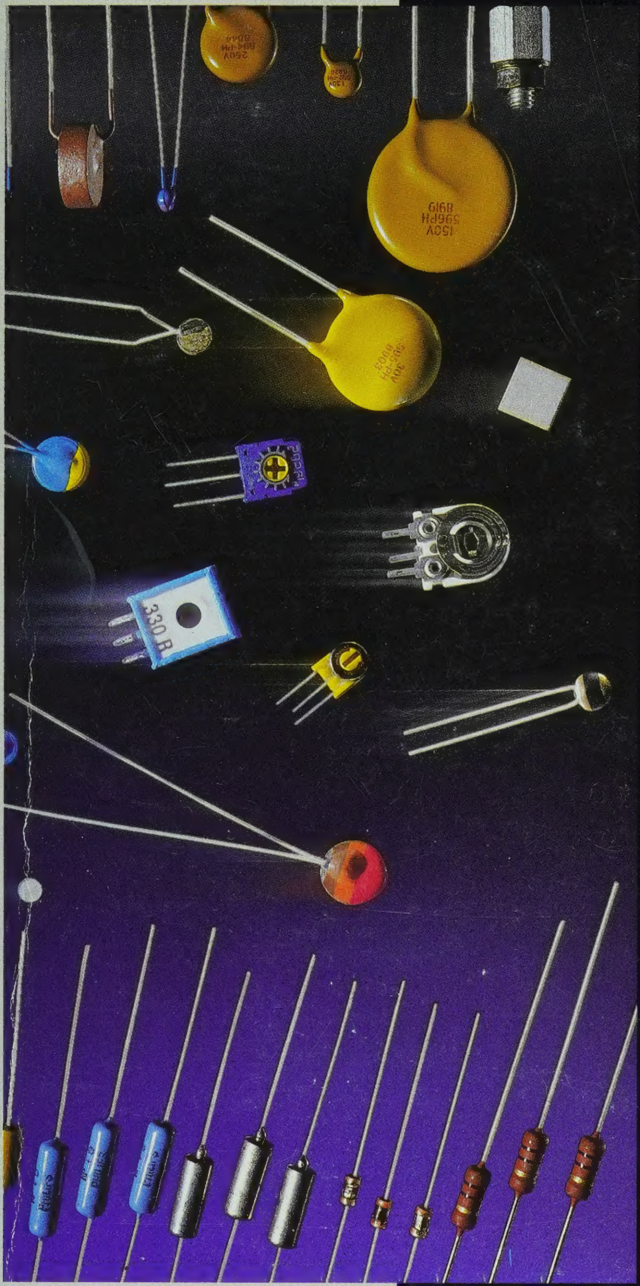


1990-91 Resistor/Capacitor Data Book

Philips Components

PHILIPS

Table of Contents

Resistor/Capacitor Data Book

ALPHA NUMERIC INDEX

Aluminum Electrolytic Capacitors

QUICK REFERENCE INDEX

STANDARD DC PRODUCT

Series	Description	Capacitance Range (μF)	Working Voltage Range (Volts)	Operating Temperature Range (°C)	Nominal Case Size D x L	Page
AXIAL LEAD						
3070	Miniature Long Life	1.0-15,000	6.3-385	–40 to +85	0.177 in. x 0.394 in. to 0.827 in. x 1.575 in.	2
COMPUTER GRADE						
3120	High Performance Ultra Long Life	330-820,000	6.0-260	–40 to +105	1 3/8 in. x 2 1/8 in. to 3 in. x 8 5/8 in.	8
3186	Standard Computer Grade	180-1,000,000	6.5-450	–40 to +85	1 3/8 in. x 2 1/8 in. to 3 in. x 8 5/8 in.	18
3188	Long Life	180-950,000	6.0-400	–40 to +105	1 3/8 in. x 2 1/8 in. to 3 in. x 8 5/8 in.	30
3191	Symmetrical Tolerance SMPS Output	2800-200,000	5.0-66	–40 to +85	1 3/8 in. x 2 1/8 in. to 2 in. x 5 5/8 in.	41

MINIATURE, RADIAL, DC PRODUCT

Series	Description	Capacitance Range (μF)	Working Voltage Range (Volts)	Operating Temperature Range (°C)	Nominal Case Size D x L	Page
3476	General Purpose	0.47-10,000	6.3-450	–40 to +85 for 100V or less –25 to +85 for 160V or greater	5 x 11 mm to 18 x 40 mm	45
3480	Low Leakage Extended Temperature	0.47-10,000	6.3-250	–55 to +105 6.3-100V –40 to +105 160-250V	5 x 11 mm to 18 x 40 mm	51
3481	Low Impedance and ESR	2.2-1,000	10-100	–55 to +105	8 x 11.5 mm to 12.5 x 42.5 mm	56

NEW, HIGH CV, DC PRODUCT

Series	Description	Capacitance Range (μF)	Working Voltage Range (Volts)	Operating Temperature Range (°C)	Nominal Case Size D x L	Page
RADIAL-TUBULAR						
Super-Snap™ 3487	Printed Circuit Board Snap-In	68-110,000	6.3-450	–40 to +85	22 x 25 mm to 35 x 80 mm	60
Super Snap™ 3488	Printed Circuit Board Snap-In	150-56,000	6.3-250	–40 to +105	25 x 35 mm 36 x 50 mm	63
Super Snap™ 3489	High CV Product For Off Line SMPS	270-4200	200-250	–40 to +85	25 x 35 mm 35 x 50 mm	67

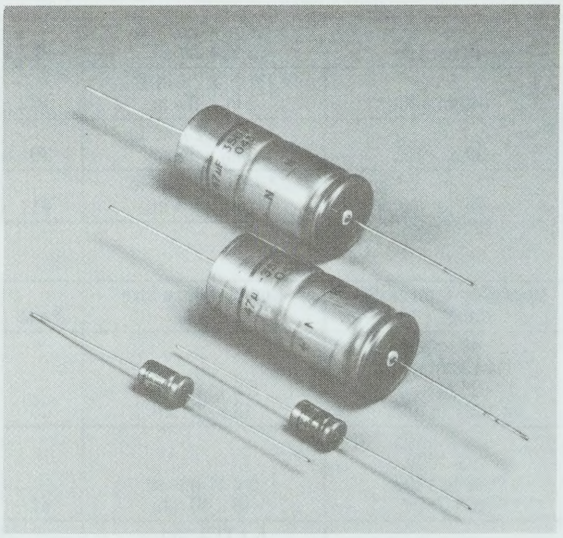
STANDARD AC PRODUCT

Series	Description	Capacitance Range (μF)	Working Voltage Range (Volts)	Operating Temperature Range (°C)	Nominal Case Size D x L	Page
3500	AC Motor Start	21-1,200	110-330	–20 to +66	1.438 x 2.750 in. to 2.562 x 4.375 in.	69

TECHNICAL INFORMATION

SERIES 3070

Miniature Axial-Leaded Aluminum Electrolytic Capacitors



DESCRIPTION

Philips Components Series 3070 Aluminum Electrolytic Capacitors are mainly used for filtering, coupling, and decoupling.

They are also suitable for higher-voltage, moderate-capacitance applications in power supplies, instrumentation and controls. The taped and reeled versions are excellent for automatic insertion and for cutting and forming equipment.

These capacitors feature extremely low leakage current, low impedance, exceptional reliability, and wide operating temperature, at a very low cost.

In construction, the capacitor has etched-aluminum-foil electrodes rolled up with a porous paper spacer which separates the anode and the cathode. The spacer is impregnated with an electrolyte which is the electrical connection between the dielectric and the cathode foil. The electrolyte used offers excellent electrical characteristics over a wide temperature range. The capacitor is housed in an aluminum case covered with a transparent blue sleeve.

FEATURES

- High CV Design.
- Wide ranges of capacitances and voltages: 1.0 to 15,000μF, 6.3 to 385WVDC.
- Very low ESR
- High ripple current capability.
- Capacitance tolerance: −10 to +50%.
- Case Sizes: 0.177 in. by 0.394 in. to 0.827 in. by 1.575 in.

SERIES 3070

Miniature Axial-Leaded Aluminum Electrolytic Capacitors

DIMENSIONS

CASE CODE	UNINSULATED CASE DIMENSION* Dimensions in Inches D nom	L nom	C	E ± .039	Dimensions in Millimeters D nom	L nom	C	E ± 1
BA	.177	.394	.024	1.299	4.5	10.0	0.6	33
DA	.236	.394	.024	1.299	6.0	10.0	0.6	33
EE	.256	.709	.032	1.299	6.5	18.0	0.8	33
FE	.315	.709	.032	1.299	8.0	18.0	0.8	33
GE	.394	.709	.032	1.299	10.0	18.0	0.8	33
GG	.394	.984	.032	1.299	10.0	25.0	0.8	33
GH	.394	1.181	.032	2.165	10.0	30.0	0.8	55
HH	.492	1.181	.032	2.165	12.5	30.0	0.8	55
JH	.591	1.181	.032	2.165	15.0	30.0	0.8	55
LH	.709	1.181	.032	2.165	18.0	30.0	0.8	55
LK	.709	1.575	.032	1.339	18.0	40.0	0.8	34
MK	.827	1.575	.032	1.339	21.0	40.0	0.8	34

*Insulated unit = D nom + .5mm. L nom + 5mm max.

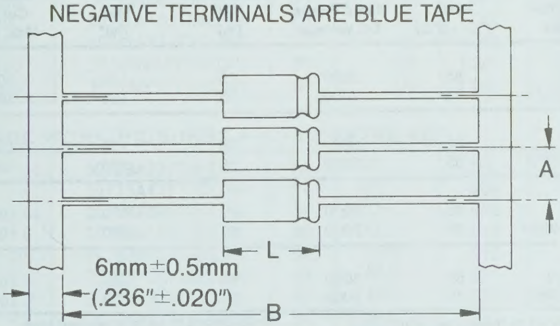
Series 3070 capacitors are marked with:

- nominal capacitance
- tolerance on nominal capacitance (where case size permits)
- rated voltage
- group number (ex. 030)
- origin code
- name of manufacturer (where case size permits)
- band to identify the negative terminal
- + sign to identify the positive terminal (where case size permits)

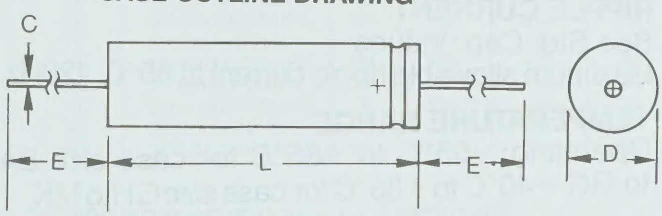
Series Code	Group Number
3073	030/031
3074	032/033
3075	041
3076	042/043

TAPE & REEL SPECIFICATIONS

NEGATIVE TERMINALS ARE BLUE TAPE



CASE OUTLINE DRAWING



Case Size	Component Pitch "A"	Inside Taping Spacing "B"	Distance Between Reel Flanges	Quantity Per Reel (Pieces)	Capacitor Length "L" Max.
BA	.197" ±.016 (5mm) ±.4	2.50" ±.059 (63.50mm) ±1.5	3.29" (83.5mm)	3,000	.413" (10.5mm)
DA	.394" ±.016 (10mm) ±.4	2.50" ± .059 (63.50mm) ±1.5	3.29" (83.5mm)	1,000	.413" (10.5mm)
EE	.394" ±.016 (10mm) ±.4	2.874" ±.063 (73.00mm) ±1.6	3.48" (88.5mm)	1,000	.728" (18.5mm)
FE	.394" ±.016 (10mm) ±.4	2.874" ±.063 (73.00mm) ±1.6	3.48" (88.5mm)	500	.728" (18.5mm)
GE	.591" ±.016 (15mm) ±.75	2.874" ±.063 (73.00mm) ±1.6	3.48" (88.5mm)	500	.728" (18.5mm)
GG	.591" ±.016 (15mm) ±.75	2.874" ±.063 (73.00mm) ±1.6	3.48" (88.5mm)	500	.984" (25.0mm)

HOW TO SPECIFY

Philips Components Series 3070 Capacitors can be completely specified using the following designation:

3070 FE 331 T 010 J P B

- **3070** — **Philips Components Product Series** (See Physical spec)
- **FE** — **Case Size Code**
- **331** — **Capacitance** XX = Significant Digits, X = Multiplier, i.e. 331 = 330μF, 330 = 33μF, 339 = 3.3μF, 338 = .33μF
- **T** — **Tolerance** T = −10+50%
- **010** — **Voltage** 010 = 10VDC, 100 = 100VDC, 6P3 = 6.3VDC
- **J** — **Mechanical Characteristics** J = No Epoxy
- **P** — **Insulation** P = Standard Polycarbonate
- **B** — **Packaging** B = Standard Bulk, T = Tape and Reel*, A = Ammo Pack

*Available for sizes BA, DA, EE, FE, GE & GG ONLY.

SERIES 3070

Miniature Axial-Leaded Aluminum Electrolytic Capacitors

PERFORMANCE CHARACTERISTICS

- **CAPACITANCE at 120Hz, 25°C**
  Rated values: 1.0μF to 15,000μF
  Tolerances: −10+50% Tolerance is stated in each part number.
- **VOLTAGE**
  Rated values: (DC + peak AC) 6.3V to 385V
  Surge voltage: 1.15 X rated voltage ≤ 250 WVDC
  1.10 X rated voltage ≥ 350 WVDC
- **LEAKAGE CURRENT**
  See Std. Cap. Values
  Capacitor is conditioned for 30 minutes at rated voltage; 24 hours later, rated voltage is applied for 5 minutes.
- **ESR**
  See Std. Cap. Values
  Measured at 120 Hz, 25°C
- **RIPPLE CURRENT**
  See Std. Cap. Values
  Maximum allowable ripple current at 85°C, 120Hz.
- **TEMPERATURE RANGE**
  Operating: −55°C to +85°C for case size BA to GG −40°C to +85°C for case size GH to MK
- **LOW TEMPERATURE PEFORMANCE (SERIES 3073, 3074, 3075 and 3076):** When measured at −40°C and a frequency of 120Hz, the impedance of these capacitors will not be greater than the value determined below. Reference measurements are made at 20°C and 120Hz.

RATED DC VOLTAGE	20°C IMPEDANCE MULTIPLIER
6.3	7
10	5
16	5
25−160	4
>160	7

LIFE TEST

Capacitor Series	A Ambient Temp. (°C ±3°C)	B Test Period Hours Rated Ripple DC Voltage	D Capacitance Mini. (%)*	E ESR Max. (%)*	F Leakage Current Max. (%)**
3073					
6.4V	85	2000	75	130	100
10−100V	85	2000	85	130	100
3074					
6.3V	85	5000	70	130	100
10−100V	85	5000	85	130	100
3075					
160V	85	2000	70	150	100
250−385V	85	2000	85	150	100
3076					
≤160V	85	5000	85	130	100
250−385V	85	5000	90	130	100

*Referenced to measured initial value. **Referenced to initial specified limit.

STANDARD CAPACITANCE VALUES

Capacitance uF	Philips Components Part Number	Case Code	Max. ESR (OHMS) 120 Hz 25°	Max. RMS Ripple Current AMPS @ 120 Hz 85°	Max. Leakage After 1 Min. uA
6.3 VDC WORKING/SURGE = 1.15 X RATED VDC					
33	3073BA330T6P3JPA	BA	12.1	.042	11
68	3073BA680T6P3JPA	BA	5.86	.053	22
150	3073DA151T6P3JPA	DA	2.66	.087	10
470	3073FE471T6P3JPA	FE	0.85	.220	22
680	3073GE681T6P3JPA	GE	0.59	.350	30
1000	3073GG102T6P3JPA	GG	0.40	.480	42
1500	3074GH152T6P3JPB	GH	.300	.450	61
2200	3074HH222T6P3JPB	HH	.210	.610	88
3300	3074JH332T6P3JPB	JH	.150	.790	129
4700	3074LH472T6P3JPB	LH	.120	1.000	182
6800	3074LK682T6P3JPB	LK	.090	1.280	261
10000	3074MK103T6P3JPB	MK	.070	1.570	382
15000	3074MK153T6P3JPB	MK	.070	1.600	571
10 VDC WORKING/SURGE = 1.15 X RATED VDC					
22	3073BA220T010JPA	BA	14.5	.042	11
47	3073BA470T010JPA	BA	6.78	.053	24
100	3073DA101T010JPA	DA	3.19	.087	10
220	3073EE221T010JPA	EE	1.45	.150	18
330	3073FE331T010JPA	FE	0.97	.220	24
470	3073GE471T010JPA	GE	0.68	.350	33
680	3073GG681T010JPA	GG	0.47	.480	45
1000	3074GH102T010JPB	GH	.320	.430	64
1500	3074HH152T010JPB	HH	.250	.570	94
2200	3074JH222T010JPB	JH	.180	.740	136
3300	3074LH332T010JPB	LH	.130	.950	202
4700	3074LK472T010JPB	LK	.100	1.220	286
6800	3074MK682T010JPB	MK	.080	1.500	412
10000	3074MK103T010JPB	MK	.080	1.520	604

Capacitance uF	Philips Components Part Number	Case Code	Max. ESR (OHMS) 120 Hz 25°	Max. RMS Ripple Current AMPS @ 120 Hz 85°	Max. Leakage After 1 Min. uA
16 VDC WORKING/SURGE = 1.15 X RATED VDC					
15	3073BA150T016JPA	BA	17.0	.042	12
33	3073BA330T016JPA	BA	7.72	.053	27
68	3073DA680T016JPA	DA	3.75	.087	11
150	3073EE151T016JPA	EE	1.70	.150	19
220	3073FE221T016JPA	FE	1.16	.220	26
330	3073GE331T016JPA	GE	.78	.350	36
470	3073GG471T016JPA	GG	.55	.480	49
680	3074GH681T016JPB	GH	.380	.400	70
1000	3074HH102T016JPB	HH	.260	.550	100
1500	3074JH152T016JPB	JH	.210	.680	148
2200	3074LH222T016JPB	LH	.150	.880	216
3300	3074LK332T016JPB	LK	.110	1.160	321
4700	3074MK472T016JPB	MK	.090	1.430	455
6800	3074MK682T016JPB	MK	.080	1.460	657
25 VDC WORKING/SURGE = 1.15 X RATED VDC					
10	3073BA100T025JPA	BA	22.3	036	13
22	3073BA220T025JPA	BA	10.2	043	28
47	3073DA470T025JPA	DA	4.80	083	12
100	3073EE101T025JPA	EE	2.23	.120	19
150	3073FE151T025JPA	FE	1.49	.190	27
220	3073GE221T025JPA	GE	1.02	.280	37
330	3073GG331T025JPA	GG	.680	.350	54
470	3074GH471T025JPB	GH	.470	.360	75
680	3074HH681T025JPB	HH	.320	.500	106
1000	3074JH102T025JPB	JH	.220	.660	154
1500	3074LH152T025JPB	LH	.180	.810	229
2200	3074LK222T025JPB	LK	.130	1.060	334
3300	3074MK332T025JPB	MK	.100	1.340	499
4700	3074MK472T025JPB	MK	.100	1.370	709

STANDARD CAPACITANCE VALUES

40 VDC WORKING/SURGE = 1.15 X RATED VDC

Capacitance uF	Philips Components Part Number	Case Code	Max. ESR (OHMS) 120 Hz 25°	Max. RMS Ripple Current AMPS @ 120 Hz 85°	Max. Leakage After 1 Min. uA
6.8	3073BA689T040JPA	BA	25.8	.036	14
10	3073BA100T040JPA	BA	17.6	.038	20
15	3073BA150T040JPA	BA	11.7	.043	30
22	3073DA220T040JPA	DA	8.00	.061	9
33	3073DA330T040JPA	DA	5.31	.083	12
47	3073EE470T040JPA	EE	3.73	.120	16
100	3073FE101T040JPA	FE	1.75	.190	28
150	3073GE151T040JPA	GE	1.17	.280	40
220	3073GG221T040JPA	GG	.800	.430	57
220	3074GH221T040JPB	GH	.860	.260	57
330	3074HH331T040JPB	HH	.580	.370	84
470	3074HH471T040JPB	HH	.400	.440	117
680	3074JH681T040JPB	JH	.280	.580	167
1000	3074LH102T040JPB	LH	.190	.780	244
1500	3074LK152T040JPB	LK	.160	.970	364
2200	3074MK222T040JPB	MK	.120	1.220	532
3300	3074MK332T040JPB	MK	.110	1.284	796

63 VDC WORKING/SURGE = 1.15 X RATED VDC

Capacitance uF	Philips Components Part Number	Case Code	Max. ESR (OHMS) 120 Hz 25°	Max. RMS Ripple Current AMPS @ 120 Hz 85°	Max. Leakage After 1 Min. uA
.33	3073BA338T063JPA	BA	435	.005	5
.47	3073BA478T063JPA	BA	305	.008	5
.68	3073BA688T063JPA	BA	211	.010	5
1.0	3073BA109T063JPA	BA	143	.012	5
1.5	3073BA159T063JPA	BA	95.6	.012	5
2.2	3073BA229T063JPA	BA	65.2	.021	7
3.3	3073BA339T063JPA	BA	46.5	.025	11
4.7	3073BA479T063JPA	BA	30.5	.031	15
6.8	3073BA689T063JPA	BA	21.1	.035	22
10	3073DA100T063JPA	DA	12.8	.051	7
15	3073DA150T063JPA	DA	8.50	.061	10
22	3073EE220T063JPA	EE	5.79	.090	13
47	3073FE470T063JPA	FE	2.71	.120	22
68	3073GE680T063JPA	GE	1.88	.200	30
100	3073GG101T063JPA	GG	1.28	.260	42
150	3074GH151T063JPB	GH	.900	.260	61
220	3074HH221T063JPB	HH	.614	.350	88
330	3074JH331T063JPB	JH	.410	.480	129
470	3074JH471T063JPB	JH	.290	.570	182
680	3074LH681T063JPB	LH	.200	.770	261
1000	3074MK102T063JPB	MK	.140	1.140	382
1500	3074MK152T063JPB	MK	.150	1.110	571

100 VDC WORKING/SURGE = 1.15 X RATED VDC

Capacitance uF	Philips Components Part Number	Case Code	Max. ESR (OHMS) 120 Hz 25°	Max. RMS Ripple Current AMPS @ 120 Hz 85°	Max. Leakage After 1 Min. uA
1.0	3073BA109T100JPA	BA	128	.014	5
2.2	3073BA229T100JPA	BA	57.9	.025	11
3.3	3073BA339T100JPA	BA	38.6	.035	17
4.7	3073DA479T100JPA	DA	23.7	.038	22
6.8	3073DA689T100JPA	DA	16.4	.061	34
10	3073EE100T100JPA	EE	11.2	.090	50
22	3073FE220T100JPA	FE	5.07	.120	80
33	3073GE330T100JPA	GE	3.38	.200	119
47	3073GG470T100JPA	GG	2.37	.260	33
68	3074GH680T100JPB	GH	3.53	.130	45
100	3074HH101T100JPB	HH	2.40	.190	64
150	3074JH151T100JPB	JH	1.60	.250	94
220	3074LH221T100JPB	LH	1.09	.330	136
330	3074LK331T100JPB	LK	.730	.460	202
470	3074MK471T100JPB	MK	.510	.600	286
680	3074MK681T100JPB	MK	.420	.650	412

160 VDC WORKING/SURGE = 1.15 X RATED VDC

Capacitance uF	Philips Components Part Number	Case Code	Max. ESR (OHMS) 120 Hz 25°	Max. RMS Ripple Current AMPS @ 120 Hz 85°	Max. Leakage After 1 Min. uA
4.7	3075EE479T160JPA	EE	53.2	.026	38
10	3075FE100T160JPA	FE	25.0	.041	68
22	3075GG220T160JPA	GG	11.4	.077	126
22	3076GH220T160JPB	GH	6.80	.106	42
33	3076HH330T160JPB	HH	4.50	.146	58
47	3076JH470T160JPB	JH	3.20	.194	78
68	3076JH680T160JPB	JH	2.20	.233	108
100	3076LH101T160JPB	LH	1.50	.313	154
150	3076LK151T160JPB	LK	1.00	.433	226
220	3076MK221T160JPB	MK	.070	.571	327

250 VDC WORKING/SURGE = 1.15 X RATED VDC

Capacitance uF	Philips Components Part Number	Case Code	Max. ESR (OHMS) 120 Hz 25°	Max. RMS Ripple Current AMPS @ 120 Hz 85°	Max. Leakage After 1 Min. uA
2.2	3075EE229T250JPA	EE	132	.018	28
4.7	3075FE479T250JPA	FE	61.7	.029	55
10	3075GG100T250JPA	GG	29.0	.055	95
10	3076GH100T250JPB	GH	15.0	.072	33
15	3076HH150T250JPB	HH	10.0	.100	44
22	3076HH220T250JPB	HH	6.80	.120	60
33	3076JH330T250JPB	JH	4.50	.162	84
47	3076LH470T250JPB	LH	3.20	.215	116
68	3076LK680T250JPB	LK	2.20	.291	163
100	3076MK101T250JPB	MK	1.50	.385	235

350 VDC WORKING/SURGE = 1.1 X RATED VDC

Capacitance uF	Philips Components Part Number	Case Code	Max. ESR (OHMS) 120 Hz 25°	Max. RMS Ripple Current AMPS @ 120 Hz 85°	Max. Leakage After 1 Min. uA
4.7	3075GE479T350JPA	GE	68.1	.032	69
6.8	3076GH689T350JPB	GH	22.0	.060	32
10	3076HH100T350JPB	HH	15.0	.081	42
15	3076HH150T350JPB	HH	10.0	.100	57
22	3076JH220T350JPB	JH	6.80	.133	79
33	3076LH330T350JPB	LH	4.50	.162	114
47	3076LK470T350JPB	LK	3.20	.242	158
68	3076MK680T350JPB	MK	2.20	.317	224

385 VDC WORKING/SURGE = 1.1 X RATED VDC

Capacitance uF	Philips Components Part Number	Case Code	Max. ESR (OHMS) 120 Hz 25°	Max. RMS Ripple Current AMPS @ 120 Hz 85°	Max. Leakage After 1 Min. uA
1.0	3075EE109T385JPA	EE	335	.012	19
2.2	3075FE229T385JPA	FE	152	.023	42
4.7	3075GG479T385JPA	GG	71.3	.043	71
6.8	3076GH689T385JPB	GH	22.0	.060	34
10	3076HH100T385JPB	HH	15.0	.081	45
15	3076HH150T385JPB	HH	10.0	.110	62
22	3076LH220T385JPB	LH	6.80	.147	86
33	3076LK330T385JPB	LK	4.50	.203	124
47	3076LK470T385JPB	LK	3.20	.242	173
68	3076MK680T385JPB	MK	2.20	.317	246

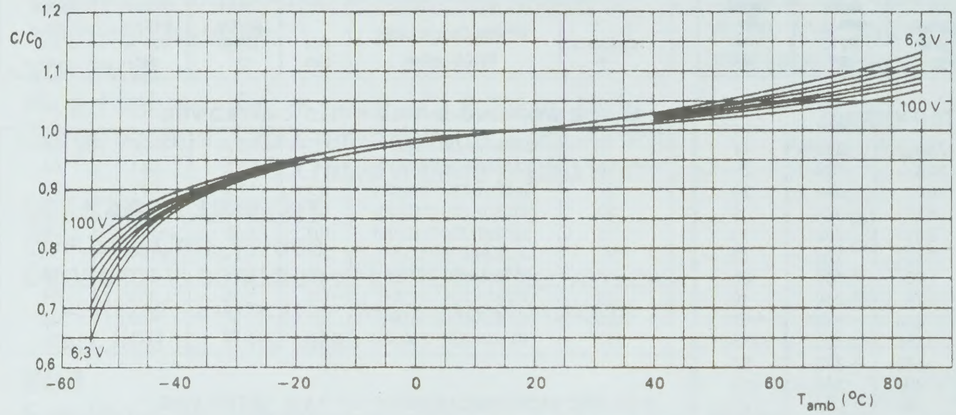
SERIES 3070

Miniature Axial-Leaded Aluminum Electrolytic Capacitors

TYPICAL PERFORMANCE

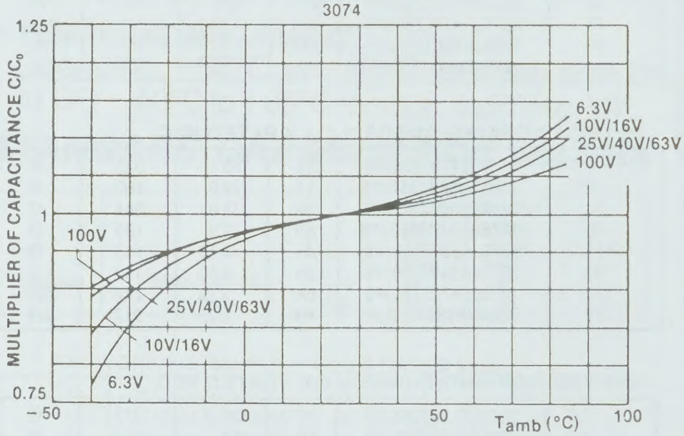
CAPACITANCE vs. TEMPERATURE

3073



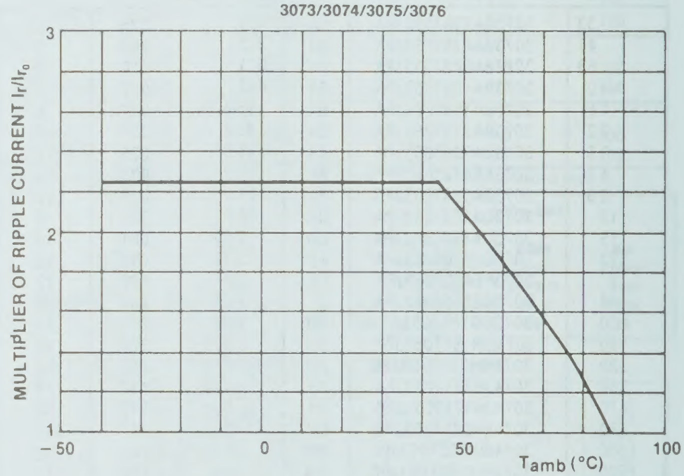
Multiplier of capacitance (C/C_0) as a function of ambient temperature; case sizes BA to GG C_0 = capacitance at 20 °C 120 Hz.

3074



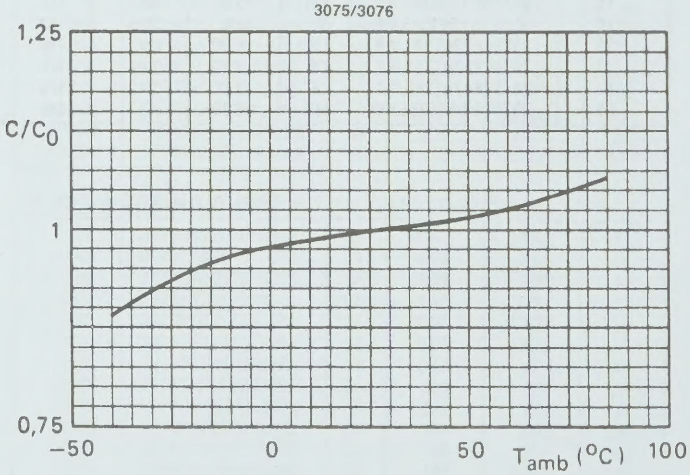
Typical capacitance as a function of ambient temperature
C_0 = capacitance at 25°C, 120Hz

3073/3074/3075/3076



Typical ripple current as a function of ambient temperature
I_{r_0} = ripple current at 85°C, 120Hz

3075/3076

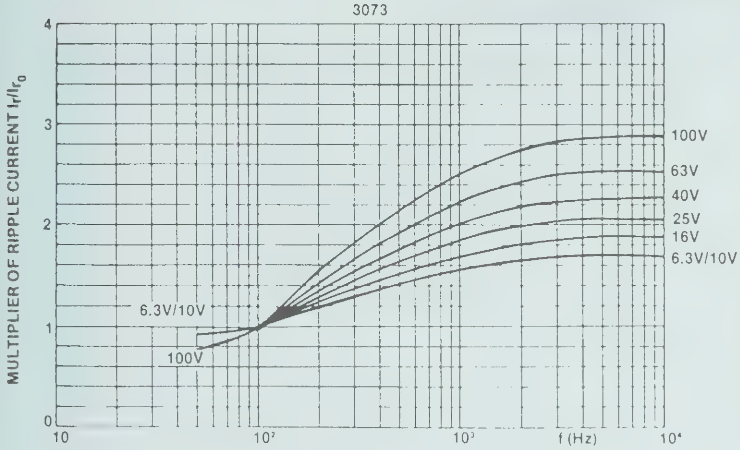


Multiplier of capacitance (c/co) as a function of ambient temperature
C_O = capacitance at 25°C, 120 Hz

TYPICAL PERFORMANCE

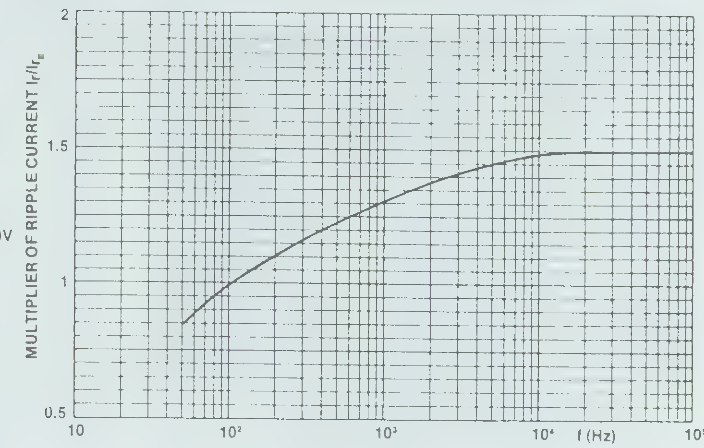
RIPPLE CURRENT vs. FREQUENCY

3073



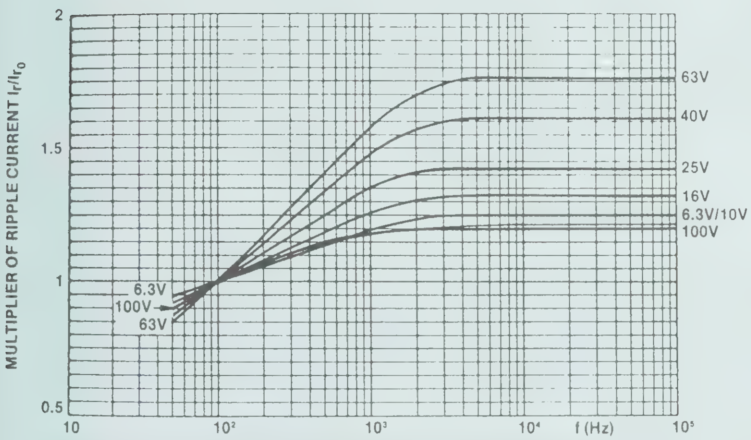
Typical ripple current as a function of frequency
I_{r_0} = ripple current at 85°C, 120 Hz

3075/3076



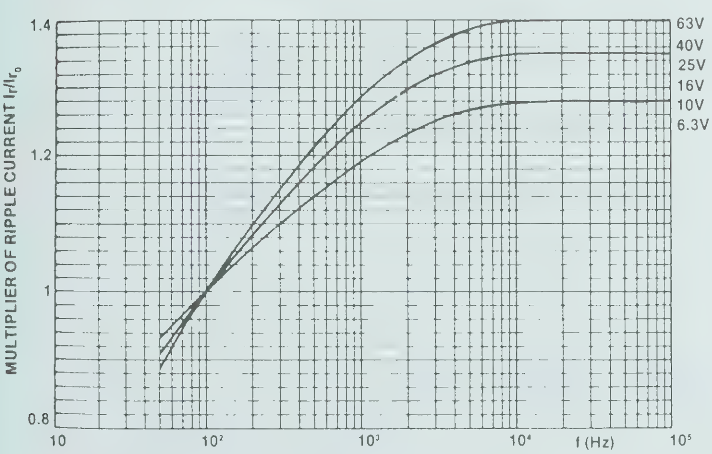
Typical ripple current as a function of frequency
I_{r_0} = ripple current at 85°C, 120 Hz.

3074 (CASES GH—LH)



Typical ripple current as a function of frequency
I_{r_0} = ripple current at 85°C, 120 Hz

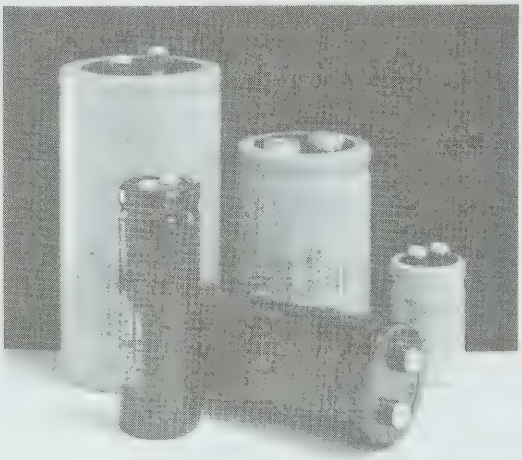
3074 (CASES LK—MK)



Typical ripple current as a function of frequency
I_{r_0} = ripple current at 85°C, 120H.

SERIES 3120

High-Performance Computer-Grade Aluminum Electrolytic Capacitors



Extended Operating Temperature Range (+105°C) Long Operating Life (3000 hrs.) with Rated DC Voltage and Ripple Current. (+85°C)

DESCRIPTION:

Series 3120 computer-grade offer performance suited to applications where high CV, wide operating temperature range, and low ESR are critical.

They employ a newly developed non-aqueous environmentally acceptable glycol based electrolyte, permitting good operational characteristics at 105°C. Carefully controlled and highly optimized etching and anodizing processes result in exceptionally high CV per unit volume. Special computer controlled symmetrical multiple tabbing techniques minimize ESR and ESL. Custom designed and patented case construction anchors the element and eliminates the need for potting compound. This results in a uniform space for gas expansion with more reliable operation of the safety vent. The combination of all these features result in longer operating and storage life.

In addition to the above, these advanced materials and manufacturing processes provide Series 3120 capacitors with high ripple-current ratings and low impedance and DC leakage.

FEATURES:

- Operating temperature range: −40°C to +105°C.
- Excellent temperature stability during 3000 hours of life-test with rated ripple current, at 85°C and during 500 hours at 105°C shelf-life test.
- Very low ESR and impedance in the frequency range of 120 Hz to 100 kHz.
- High ripple-current ratings in the 120 Hz to 100 kHz frequency range.
- Voltage range: 6 to 250 WVDC.
- Custom designed case construction* eliminates potting compound.

For Application Guidelines see pages 82-91

*Patent pending

6.0 VDC WORKING 10.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
40000	3120BA403U006AM	BA	0.0281	7.2
48000	3120BB483U006AM	BB	0.0243	8.4
64000	3120BC643U006AM	BC	0.0197	10.0
80000	3120BD803U006AM	BD	0.0170	11.5
96000	3120BE963U006AM	BE	0.0153	12.8
100000	3120BF104U006AM	BF	0.0076	19.0
120000	3120BG124U006AM	BG	0.0124	15.6
140000	3120BH144U006AM	BH	0.0118	16.7
72000	3120DA723U006AM	DA	0.0140	11.9
86000	3120DB863U006AM	DB	0.0122	13.8
110000	3120DC114U006AM	DC	0.0100	16.3
130000	3120DD134U006AM	DD	0.0106	16.7
170000	3120DE174U006AM	DE	0.0078	20.6
200000	3120DF204U006AM	DF	0.0072	22.4
230000	3120DG234U006AM	DG	0.0068	24.1
250000	3120DH254U006AM	DH	0.0065	25.7
74000	3120EA743U006AM	EA	0.0112	14.5
100000	3120EB104U006AM	EB	0.0102	16.4
140000	3120EC144U006AM	EC	0.0069	21.2
170000	3120ED174U006AM	ED	0.0072	22.0
220000	3120EE224U006AM	EE	0.0055	26.4
260000	3120EF264U006AM	EF	0.0052	28.6
290000	3120EG294U006AM	EG	0.0049	30.0
330000	3120EH334U006AM	EH	0.0047	30.0
180000	3120FB184U006AM	FB	0.0074	22.2
240000	3120FC244U006AM	FC	0.0062	25.9
290000	3120FD294U006AM	FD	0.0051	29.9
370000	3120FE374U006DM	FE	0.0050	31.9
430000	3120FF434U006DM	FF	0.0047	34.5
490000	3120FG494U006DM	FG	0.0044	36.9
560000	3120FH564U006DM	FH	0.0042	39.1
360000	3120GC364U006DM	GC	0.0046	33.8
460000	3120GD464U006DM	GD	0.0041	37.6
550000	3120GE554U006DM	GE	0.0038	41.0
640000	3120GF644U006DM	GF	0.0036	44.0
730000	3120GG734U006DM	GG	0.0034	45.0
820000	3120GH824U006DM	GH	0.0033	45.0

7.5 VDC WORKING 12.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
37000	3120BA373U7P5AM	BA	0.0282	7.2
44090	3120BB443U7P5AM	BB	0.0245	8.4
59000	3120BC593U7P5AM	BC	0.0198	10.0
74000	3120BD743U7P5AM	BD	0.0171	11.4
89000	3120BE893U7P5AM	BE	0.0154	12.7
100000	3120BF104U7P5AM	BF	0.0133	14.4
110000	3120BG114U7P5AM	BG	0.0125	15.5
120000	3120BH124U7P5AM	BH	0.0068	21.9
67000	3120DA673U7P5AM	DA	0.0140	11.9
80000	3120DB803U7P5AM	DB	0.0122	13.7
100000	3120DC104U7P5AM	DC	0.0100	16.2
130000	3120DD134U7P5AM	DD	0.0087	18.5
150000	3120DE154U7P5AM	DE	0.0094	18.7
180000	3120DF184U7P5AM	DF	0.0073	22.4
200000	3120DG204U7P5AM	DG	0.0080	22.2
230000	3120DH234U7P5AM	DH	0.0076	23.8
69000	3120EA693U7P5AM	EA	0.0112	14.5
100000	3120EB104U7P5AM	EB	0.0084	18.1
130000	3120EC134U7P5AM	EC	0.0070	21.1
160000	3120ED164U7P5AM	ED	0.0072	22.0
200000	3120EE204U7P5AM	EE	0.0056	26.3
230000	3120EF234U7P5AM	EF	0.0060	26.6
270000	3120EG274U7P5AM	EG	0.0049	30.0
310000	3120EH314U7P5AM	EH	0.0047	30.0
170000	3120FB174U7P5AM	FB	0.0074	22.2
230000	3120FC234U7P5AM	FC	0.0062	25.8
290000	3120FD294U7P5AM	FD	0.0055	29.0
340000	3120FE344U7P5DM	FE	0.0050	31.9
400000	3120FF404U7P5DM	FF	0.0047	34.5
460000	3120FG464U7P5DM	FG	0.0044	36.8
520000	3120FH524U7P5DM	FH	0.0043	39.0
340000	3120GC344U7P5DM	GC	0.0046	33.8
430000	3120GD434U7P5DM	GD	0.0041	37.6
510000	3120GE514U7P5DM	GE	0.0038	40.9
600000	3120GF604U7P5DM	GF	0.0036	44.0
680000	3120GG684U7P5DM	GG	0.0034	45.0
770000	3120GH774U7P5DM	GH	0.0033	45.0

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10.0 VDC WORKING 15.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
27000	3120BA273U010AM	BA	0.0287	7.1
33000	3120BB333U010AM	BB	0.0248	8.3
43000	3120BC433U010AM	BC	0.0254	8.8
54000	3120BD543U010AM	BD	0.0216	10.2
65000	3120BE653U010AM	BE	0.0191	11.4
75000	3120BF753U010AM	BF	0.0135	14.3
86000	3120BG863U010AM	BG	0.0126	15.5
96000	3120BH963U010AM	BH	0.0143	15.2
49000	3120DA493U010AM	DA	0.0143	11.8
59000	3120DB593U010AM	DB	0.0124	13.6
79000	3120DC793U010AM	DC	0.0101	16.1
98000	3120DD983U010AM	DD	0.0107	16.6
110000	3120DE114U010AM	DE	0.0080	20.3
130000	3120DF134U010AM	DF	0.0074	22.2
150000	3120DG154U010AM	DG	0.0069	23.9
170000	3120DH174U010AM	DH	0.0066	25.5
51000	3120EA513U010AM	EA	0.0190	11.1
77000	3120EB773U010AM	EB	0.0137	14.1
100000	3120EC104U010AM	EC	0.0111	16.7
120000	3120ED124U010AM	ED	0.0096	19.0
150000	3120EE154U010AM	EE	0.0086	21.2
170000	3120EF174U010AM	EF	0.0061	26.4
200000	3120EG204U010AM	EG	0.0074	24.9
230000	3120EH234U010AM	EH	0.0071	26.6
120000	3120FB124U010AM	FB	0.0106	18.6
170000	3120FC174U010AM	FC	0.0063	25.7
210000	3120FD214U010AM	FD	0.0055	28.9
250000	3120FE254U010DM	FE	0.0050	31.7
290000	3120FF294U010DM	FF	0.0054	31.9
340000	3120FG344U010DM	FG	0.0045	36.7
380000	3120FH384U010DM	FH	0.0043	38.8
250000	3120GC254U010DM	GC	0.0055	30.7
310000	3120GD314U010DM	GD	0.0049	34.3
370000	3120GE374U010DM	GE	0.0044	38.1
440000	3120GF444U010DM	GF	0.0042	40.6
500000	3120GG504U010DM	GG	0.0040	43.2
560000	3120GH564U010DM	GH	0.0037	45.0

16.0 VDC WORKING 20.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
19000	3120BA193U016AM	BA	0.0294	7.0
23000	3120BB233U016AM	BB	0.0254	8.2
31000	3120BC313U016AM	BC	0.0205	9.8
39000	3120BD393U016AM	BD	0.0177	11.3
47000	3120BE473U016AM	BE	0.0158	12.6
54000	3120BF543U016AM	BF	0.0137	14.2
62000	3120BG623U016AM	BG	0.0128	15.4
70000	3120BH703U016AM	BH	0.0121	16.4
35000	3120DA353U016AM	DA	0.0146	11.6
43000	3120DB433U016AM	DB	0.0159	12.0
57000	3120DC573U016AM	DC	0.0103	16.0
71000	3120DD713U016AM	DD	0.0089	18.2
86000	3120DE863U016AM	DE	0.0080	20.3
100000	3120DF104U016AM	DF	0.0088	20.3
110000	3120DG114U016AM	DG	0.0082	21.9
120000	3120DH124U016AM	DH	0.0067	25.3
37000	3120EA373U016AM	EA	0.0256	9.6
55000	3120EB553U016AM	EB	0.0140	14.0
74000	3120EC743U016AM	EC	0.0113	16.6
94000	3120ED943U016AM	ED	0.0122	16.9
110000	3120EE114U016AM	EE	0.0108	18.9
130000	3120EF134U016AM	EF	0.0098	20.8
140000	3120EG144U016AM	EG	0.0075	24.7
160000	3120EH164U016AM	EH	0.0072	26.4
93000	3120FB933U016AM	FB	0.0107	18.5
120000	3120FC124U016AM	FC	0.0088	21.7
150000	3120FD154U016AM	FD	0.0076	24.6
180000	3120FE184U016AM	FE	0.0068	27.2
210000	3120FF214U016AM	FF	0.0063	29.6
240000	3120FG244U016DM	FG	0.0059	31.8
270000	3120FH274U016DM	FH	0.0057	33.8
180000	3120GC184U016DM	GC	0.0072	26.9
220000	3120GD224U016DM	GD	0.0063	30.3
270000	3120GE274U016DM	GE	0.0054	34.5
320000	3120GF324U016DM	GF	0.0049	37.4
360000	3120GG364U016DM	GG	0.0050	38.7
410000	3120GH414U016DM	GH	0.0044	42.7
650000	3120GN654U016DM	GN	0.0038	45.0

For Application Guidelines see pages 82-91

20.0 VDC WORKING 24.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
18000	3120BA183U020AM	BA	0.0381	6.2
21000	3120BB213U020AM	BB	0.0255	8.2
29000	3120BC293U020AM	BC	0.0259	8.7
36000	3120BD363U020AM	BD	0.0177	11.2
43000	3120BE433U020AM	BE	0.0159	12.5
50000	3120BF503U020AM	BF	0.0138	14.1
57000	3120BG573U020AM	BG	0.0128	15.3
64000	3120BH643U020AM	BH	0.0122	16.4
32000	3120DA323U020AM	DA	0.0147	11.6
39000	3120DB393U020AM	DB	0.0127	13.5
52000	3120DC523U020AM	DC	0.0104	15.9
65000	3120DD653U020AM	DD	0.0090	18.2
79000	3120DE793U020AM	DE	0.0081	20.2
92000	3120DF923U020AM	DF	0.0075	22.1
100000	3120DG104U020AM	DG	0.0083	21.9
110000	3120DH114U020AM	DH	0.0067	25.3
34000	3120EA343U020AM	EA	0.0194	11.0
51000	3120EB513U020AM	EB	0.0140	14.0
68000	3120EC683U020AM	EC	0.0113	16.6
85000	3120ED853U020AM	ED	0.0098	18.9
100000	3120EE104U020AM	EE	0.0109	18.9
110000	3120EF114U020AM	EF	0.0081	22.9
130000	3120EG134U020AM	EG	0.0076	24.7
150000	3120EH154U020AM	EH	0.0086	24.1
85000	3120FB853U020AM	FB	0.0107	18.4
110000	3120FC114U020AM	FC	0.0088	21.7
140000	3120FD144U020AM	FD	0.0076	24.6
170000	3120FE174U020AM	FE	0.0069	27.2
190000	3120FF194U020AM	FF	0.0064	29.5
220000	3120FG224U020DM	FG	0.0060	31.7
250000	3120FH254U020DM	FH	0.0057	33.8
160000	3120GC164U020AM	GC	0.0073	26.8
210000	3120GD214U020DM	GD	0.0060	31.2
250000	3120GE254U020DM	GE	0.0054	34.4
290000	3120GF294U020DM	GF	0.0053	36.1
330000	3120GG334U020DM	GG	0.0050	38.7
370000	3120GH374U020DM	GH	0.0048	41.1
620000	3120GN624U020DM	GN	0.0042	45.0

25.0 VDC WORKING 40.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
13000	3120BA133U025AM	BA	0.0389	6.1
16000	3120BB163U025AM	BB	0.0332	7.2
21000	3120BC213U025AM	BC	0.0265	8.6
26000	3120BD263U025AM	BD	0.0224	10.0
32000	3120BE323U025AM	BE	0.0198	11.2
36000	3120BF363U025AM	BF	0.0171	12.7
42000	3120BG423U025AM	BG	0.0157	13.8
47000	3120BH473U025AM	BH	0.0147	14.9
24000	3120DA243U025AM	DA	0.0190	10.2
28000	3120DB283U025AM	DB	0.0164	11.9
38000	3120DC383U025AM	DC	0.0131	14.2
48000	3120DD483U025AM	DD	0.0111	16.3
57000	3120DE573U025AM	DE	0.0099	18.3
67000	3120DF673U025AM	DF	0.0090	20.1
77000	3120DG773U025AM	DG	0.0084	21.8
86000	3120DH863U025AM	DH	0.0079	23.3
25000	3120EA253U025AM	EA	0.0262	9.5
37000	3120EB373U025AM	EB	0.0185	12.1
50000	3120EC503U025AM	EC	0.0147	14.5
62000	3120ED623U025AM	ED	0.0125	16.7
75000	3120EE753U025AM	EE	0.0110	18.7
87000	3120EF873U025AM	EF	0.0100	20.6
100000	3120EG104U025AM	EG	0.0092	22.4
110000	3120EH114U025AM	EH	0.0087	24.0
62000	3120FB623U025AM	FB	0.0140	16.1
83000	3120FC833U025AM	FC	0.0112	19.2
100000	3120FD104U025AM	FD	0.0096	21.9
120000	3120FE124U025AM	FE	0.0085	24.4
140000	3120FF144U025AM	FF	0.0078	26.7
160000	3120FG164U025AM	FG	0.0072	28.9
180000	3120FH184U025DM	FH	0.0068	30.9
120000	3120GC124U025AM	GC	0.0093	23.8
150000	3120GD154U025AM	GD	0.0079	27.0
180000	3120GE184U025AM	GE	0.0071	30.0
210000	3120GF214U025DM	GF	0.0065	32.7
240000	3120GG244U025DM	GG	0.0060	35.3
270000	3120GH274U025DM	GH	0.0057	37.7
450000	3120GN454U025DM	GN	0.0048	45.0

SERIES 3120

30.0 VDC WORKING 45.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
11000	3120BA113U030AM	BA	0.0394	6.1
13000	3120BB133U030AM	BB	0.0338	7.1
18000	3120BC183U030AM	BC	0.0267	8.6
23000	3120BD233U030AM	BD	0.0226	9.9
27000	3120BE273U030AM	BE	0.0200	11.2
31000	3120BF313U030AM	BF	0.0172	12.6
36000	3120BG363U030AM	BG	0.0159	13.8
41000	3120BH413U030AM	BH	0.0148	14.9
20000	3120DA203U030AM	DA	0.0193	10.1
25000	3120DB253U030AM	DB	0.0165	11.8
33000	3120DC333U030AM	DC	0.0132	14.1
41000	3120DD413U030AM	DD	0.0113	16.2
50000	3120DE503U030AM	DE	0.0100	18.2
58000	3120DF583U030AM	DF	0.0091	20.0
67000	3120DG673U030AM	DG	0.0084	21.7
75000	3120DH753U030AM	DH	0.0080	23.2
21000	3120EA213U030AM	EA	0.0265	9.4
32000	3120EB323U030AM	EB	0.0187	12.1
43000	3120EC433U030AM	EC	0.0149	14.5
54000	3120ED543U030AM	ED	0.0126	16.6
65000	3120EE653U030AM	EE	0.0111	18.7
76000	3120EF763U030AM	EF	0.0101	20.5
86000	3120EG863U030AM	EG	0.0093	22.3
97000	3120EH973U030AM	EH	0.0087	23.9
54000	3120FB543U030AM	FB	0.0141	16.1
72000	3120FC723U030AM	FC	0.0113	19.1
90000	3120FD903U030AM	FD	0.0096	21.8
100000	3120FE104U030AM	FE	0.0086	24.3
120000	3120FF124U030AM	FF	0.0078	26.6
140000	3120FG144U030AM	FG	0.0072	28.8
160000	3120FH164U030DM	FH	0.0068	30.9
100000	3120GC104U030AM	GC	0.0094	23.6
130000	3120GD134U030AM	GD	0.0080	26.9
160000	3120GE164U030AM	GE	0.0071	29.9
180000	3120GF184U030DM	GF	0.0065	32.6
210000	3120GG214U030DM	GG	0.0060	35.2
240000	3120GH244U030DM	GH	0.0057	37.6
390000	3120GN394U030DM	GN	0.0048	45.0

35.0 VDC WORKING 50.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
7800	3120BA782U035AM	BA	0.0407	6.0
9400	3120BB942U035AM	BB	0.0348	7.0
12000	3120BC123U035AM	BC	0.0277	8.4
15000	3120BD153U035AM	BD	0.0234	9.8
18000	3120BE183U035AM	BE	0.0207	11.0
21000	3120BF213U035AM	BF	0.0178	12.4
24000	3120BG243U035AM	BG	0.0163	13.6
27000	3120BH273U035AM	BH	0.0153	14.6
14000	3120DA143U035AM	DA	0.0570	5.9
17000	3120DB173U035AM	DB	0.0483	6.9
22000	3120DC223U035AM	DC	0.0376	8.4
28000	3120DD283U035AM	DD	0.0312	9.8
34000	3120DE343U035AM	DE	0.0269	11.1
39000	3120DF393U035AM	DF	0.0240	12.3
45000	3120DG453U035AM	DG	0.0218	13.5
51000	3120DH513U035AM	DH	0.0201	14.6
14000	3120EA143U035AM	EA	0.0274	9.3
22000	3120EB223U035AM	EB	0.0192	11.9
29000	3120EC293U035AM	EC	0.0153	14.3
36000	3120ED363U035AM	ED	0.0129	16.4
44000	3120EE443U035AM	EE	0.0114	18.4
51000	3120EF513U035AM	EF	0.0103	20.3
58000	3120EG583U035AM	EG	0.0095	22.0
66000	3120EH663U035AM	EH	0.0089	23.7
36000	3120FB363U035AM	FB	0.0145	15.9
49000	3120FC493U035AM	FC	0.0116	18.9
61000	3120FD613U035AM	FD	0.0098	21.6
73000	3120FE733U035AM	FE	0.0087	24.1
85000	3120FF853U035AM	FF	0.0079	26.4
98000	3120FG983U035AM	FG	0.0074	28.6
110000	3120FH114U035DM	FH	0.0069	30.6
72000	3120GC723U035AM	GC	0.0095	23.4
90000	3120GD903U035AM	GD	0.0081	26.7
100000	3120GE104U035AM	GE	0.0107	24.4
120000	3120GF124U035AM	GF	0.0096	26.8
140000	3120GG144U035AM	GG	0.0088	29.1
160000	3120GH164U035DM	GH	0.0058	37.3
260000	3120GN264U035DM	GN	0.0048	45.0

40.0 VDC WORKING 60.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
5300	3120BA532U040AM	BA	0.0434	5.8
6400	3120BB642U040AM	BB	0.0371	6.8
8500	3120BC852U040AM	BC	0.0293	8.2
10000	3120BD103U040AM	BD	0.0249	9.5
12000	3120BE123U040AM	BE	0.0219	10.7
14000	3120BF143U040AM	BF	0.0188	12.1
16000	3120BG163U040AM	BG	0.0172	13.2
18000	3120BH183U040AM	BH	0.0161	14.3
9600	3120DA962U040AM	DA	0.0611	5.7
10000	3120DB113U040AM	DB	0.0519	6.7
15000	3120DC153U040AM	DC	0.0402	8.1
19000	3120DD193U040AM	DD	0.0332	9.5
23000	3120DE233U040AM	DE	0.0287	10.7
27000	3120DF273U040AM	DF	0.0254	11.9
31000	3120DG313U040AM	DG	0.0231	13.1
34000	3120DH343U040AM	DH	0.0213	14.2
10000	3120EA103U040AM	EA	0.0291	9.0
15000	3120EB153U040AM	EB	0.0205	11.6
20000	3120EC203U040AM	EC	0.0162	13.9
25000	3120ED253U040AM	ED	0.0136	16.0
30000	3120EE303U040AM	EE	0.0120	18.0
35000	3120EF353U040AM	EF	0.0108	19.8
40000	3120EG403U040AM	EG	0.0100	21.5
45000	3120EH453U040AM	EH	0.0093	23.2
25000	3120FB253U040AM	FB	0.0287	11.3
33000	3120FC333U040AM	FC	0.0224	13.6
41000	3120FD413U040AM	FD	0.0187	15.7
50000	3120FE503U040AM	FE	0.0162	17.7
58000	3120FG583U040AM	FF	0.0145	19.5
67000	3120FG673U040AM	FG	0.0132	21.3
75000	3120FH753U040AM	FH	0.0123	23.0
49000	3120GC493U040AM	GC	0.0153	18.5
61000	3120GD613U040AM	GD	0.0129	21.2
74000	3120GE743U040AM	GE	0.0112	23.8
86000	3120GF863U040AM	GF	0.0101	26.2
98000	3120GG983U040AM	GG	0.0093	28.4
110000	3120GH114U040DM	GH	0.0086	30.5
180000	3120GN184U040DM	GN	0.0069	40.9

50.0 VDC WORKING 75.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
4400	3120BA442U050AM	BA	0.0458	5.6
5200	3120BB522U050AM	BB	0.0392	6.6
7000	3120BC702U050AM	BC	0.0308	8.0
8800	3120BD882U050AM	BD	0.0259	9.3
10000	3120BE103U050AM	BE	0.0229	10.4
12000	3120BF123U050AM	BF	0.0196	11.9
13000	3120BG133U050AM	BG	0.0181	12.9
15000	3120BH153U050AM	BH	0.0167	14.0
7900	3120DA792U050AM	DA	0.0626	5.6
9500	3120DB952U050AM	DB	0.0530	6.6
12000	3120DC123U050AM	DC	0.0412	8.0
15000	3120DD153U050AM	DD	0.0341	9.3
19000	3120DE193U050AM	DE	0.0293	10.6
22000	3120DF223U050AM	DF	0.0260	11.8
25000	3120DG253U050AM	DG	0.0236	13.0
28000	3120DH283U050AM	DH	0.0217	14.1
8200	3120EA822U050AM	EA	0.0935	5.0
12000	3120EB123U050AM	EB	0.0641	6.5
16000	3120EC163U050AM	EC	0.0494	7.9
20000	3120ED203U050AM	ED	0.0407	9.3
24000	3120EE243U050AM	EE	0.0349	10.5
28000	3120EF283U050AM	EF	0.0308	11.7
33000	3120EG333U050AM	EG	0.0278	12.9
37000	3120EH373U050AM	EH	0.0255	14.0
20000	3120FB203U050AM	FB	0.0290	11.2
27000	3120FC273U050AM	FC	0.0227	13.5
34000	3120FD343U050AM	FD	0.0189	15.6
41000	3120FE413U050AM	FE	0.0164	17.6
48000	3120FF483U050AM	FF	0.0146	19.4
55000	3120FG553U050AM	FG	0.0134	21.2
62000	3120FH623U050AM	FH	0.0124	22.9
40000	3120GC403U050AM	GC	0.0155	18.4
50000	3120GD503U050AM	GD	0.0130	21.1
60000	3120GE603U050AM	GE	0.0114	23.7
71000	3120GF713U050AM	GF	0.0102	26.1
81000	3120GG813U050AM	GG	0.0094	28.3
91000	3120GH913U040DM	GH	0.0087	30.4
140000	3120GN144U050DM	GN	0.0069	40.7

SERIES 3120

60.0 VDC WORKING 90.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
4000	3120BA402T060AM	BA	0.0464	5.6
4800	3120BB482T060AM	BB	0.0396	6.6
6400	3120BC642T060AM	BC	0.0312	8.0
8000	3120BD802T060AM	BD	0.0262	9.2
9600	3120BE962T060AM	BE	0.0230	10.4
11000	3120BF113T060AM	BF	0.0198	11.8
12000	3120BG123T060AM	BG	0.0182	12.9
14000	3120BH143T060AM	BH	0.0169	13.9
7200	3120DA722T060AM	DA	0.0629	5.6
8600	3120DB862T060AM	DB	0.0533	6.6
11000	3120DC113T060AM	DC	0.0414	8.0
14000	3120DD143T060AM	DD	0.0342	9.3
17000	3120DE173T060AM	DE	0.0295	10.6
20000	3120DF203T060AM	DF	0.0261	11.8
23000	3120DG233T060AM	DG	0.0237	12.9
26000	3120DH263T060AM	DH	0.0218	14.0
7500	3120EA752T060AM	EA	0.0939	5.0
11000	3120EB113T060AM	EB	0.0644	6.5
15000	3120EC153T060AM	EC	0.0496	7.9
18000	3120ED183T060AM	ED	0.0409	9.2
22000	3120EE223T060AM	EE	0.0351	10.5
26000	3120EF263T060AM	EF	0.0309	11.7
30000	3120EG303T060AM	EG	0.0279	12.9
33000	3120EH333T060AM	EH	0.0256	14.0
18000	3120FB183T060AM	FB	0.0292	11.2
25000	3120FC253T060AM	FC	0.0228	13.5
31000	3120FD313T060AM	FD	0.0190	15.6
37000	3120FE373T060AM	FE	0.0165	17.5
43000	3120FF433T060AM	FF	0.0147	19.4
50000	3120FG503T060AM	FG	0.0134	21.2
56000	3120FH563T060AM	FH	0.0124	22.8
36000	3120GC363T060AM	GC	0.0156	18.3
46000	3120GD463T060AM	GD	0.0131	21.1
55000	3120GE553T060AM	GE	0.0114	23.6
64000	3120GF643T060AM	GF	0.0103	26.0
73000	3120GG733T060DM	GG	0.0094	28.2
83000	3120GH833T060DM	GH	0.0087	30.4
130000	3120GN134T060DM	GN	0.0069	40.6

75.0 VDC WORKING 100.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
2500	3120BA252T075AM	BA	0.0508	5.4
3000	3120BB302T075AM	BB	0.0433	6.3
4000	3120BC402T075AM	BC	0.0339	7.6
5000	3120BD502T075AM	BD	0.0284	8.9
6100	3120BE612T075AM	BE	0.0247	10.0
7000	3120BF702T075AM	BF	0.0213	11.4
8000	3120BG802T075AM	BG	0.0194	12.4
9000	3120BH902T075AM	BH	0.0180	13.5
4600	3120DA462T075AM	DA	0.0653	5.5
5500	3120DB552T075AM	DB	0.0553	6.5
7300	3120DC732T075AM	DC	0.0428	7.9
9200	3120DD922T075AM	DD	0.0353	9.2
11000	3120DE113T075AM	DE	0.0304	10.4
12000	3120DF123T075AM	DF	0.0272	11.6
14000	3120DG143T075AM	DG	0.0245	12.7
16000	3120DH163T075AM	DH	0.0225	13.8
4700	3120EA472T075AM	EA	0.0968	4.9
7100	3120EB712T075AM	EB	0.0662	6.4
9500	3120EC952T075AM	EC	0.0510	7.8
11000	3120ED113T075AM	ED	0.0422	9.1
14000	3120EE143T075AM	EE	0.0360	10.4
16000	3120EF163T075AM	EF	0.0318	11.5
19000	3120EG193T075AM	EG	0.0286	12.7
21000	3120EH213T075AM	EH	0.0262	13.8
10000	3120FB103T075AM	FB	0.0280	11.4
13000	3120FC133T075AM	FC	0.0220	13.7
17000	3120FD173T075AM	FD	0.0183	15.9
20000	3120FE203T075AM	FE	0.0159	17.8
24000	3120FF243T075AM	FF	0.0142	19.7
27000	3120FG273T075AM	FG	0.0130	21.5
31000	3120FH313T075AM	FH	0.0120	23.2
20000	3120GC203T075AM	GC	0.0280	13.7
25000	3120GD253T075AM	GD	0.0232	15.8
30000	3120GE303T075AM	GE	0.0200	17.8
35000	3120GF353T075AM	GF	0.0178	19.7
40000	3120GG403T075AM	GG	0.0161	21.6
45000	3120GH453T075AM	GH	0.0148	23.3
74000	3120GN743T075DM	GN	0.0112	32.0

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85.0 VDC WORKING 105.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
1500	3120BA152T085AM	BA	0.0948	3.9
1800	3120BB182T085AM	BB	0.0801	4.6
2500	3120BC252T085AM	BC	0.0608	5.7
3100	3120BD312T085AM	BD	0.0502	6.7
3700	3120BE372T085AM	BE	0.0432	7.6
4300	3120BF432T085AM	BF	0.0373	8.6
4900	3120BG492T085AM	BG	0.0335	9.5
5500	3120BH552T085AM	BH	0.0307	10.3
2800	3120DA282T085AM	DA	0.0949	4.6
3400	3120DB342T085AM	DB	0.0798	5.4
4500	3120DC452T085AM	DC	0.0615	6.6
5700	3120DD572T085AM	DD	0.0503	7.7
6800	3120DE682T085AM	DE	0.0431	8.7
8000	3120DF802T085AM	DF	0.0379	9.8
9100	3120DG912T085AM	DG	0.0341	10.8
10000	3120DH103T085AM	DH	0.0314	11.7
2900	3120EA292T085AM	EA	0.1305	4.2
4400	3120EB442T085AM	EB	0.0888	5.5
5900	3120EC592T085AM	EC	0.0681	6.8
7400	3120ED742T085AM	ED	0.0558	7.9
8900	3120EE892T085AM	EE	0.0476	9.0
10000	3120EF103T085AM	EF	0.0421	10.0
11000	3120EG113T085AM	EG	0.0380	11.0
13000	3120EH133T085AM	EH	0.0344	12.0
6400	3120FB642T085AM	FB	0.1126	5.7
8500	3120FC852T085AM	FC	0.0863	6.9
10000	3120FD103T085AM	FD	0.0709	8.1
12000	3120FE123T085AM	FE	0.0603	9.2
15000	3120FF153T085AM	FF	0.0525	10.3
17000	3120FG173T085AM	FG	0.0471	11.3
19000	3120FH193T085AM	FH	0.0428	12.3
12000	3120GC123T085AM	GC	0.0374	11.8
15000	3120GD153T085AM	GD	0.0308	13.7
18000	3120GE183T085AM	GE	0.0265	15.5
22000	3120GF223T085AM	GF	0.0233	17.2
25000	3120GG253T085AM	GG	0.0210	18.9
28000	3120GH283T085AM	GH	0.0193	20.4
46000	3120GN463T085DM	GN	0.0143	28.3

100.0 VDC WORKING 150.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
870	3120BA871T100AM	BA	0.1010	3.8
1000	3120BB102T100AM	BB	0.0872	4.4
1300	3120BC132T100AM	BC	0.0680	5.4
1700	3120BD172T100AM	BD	0.0546	6.4
2000	3120BE202T100AM	BE	0.0472	7.3
2300	3120BF232T100AM	BF	0.0409	8.2
2700	3120BG272T100AM	BG	0.0362	9.1
3000	3120BH302T100AM	BH	0.0333	9.9
1500	3120DA152T100AM	DA	0.0975	4.5
1800	3120DB182T100AM	DB	0.0822	5.3
2500	3120DC252T100AM	DC	0.0624	6.5
3100	3120DD312T100AM	DD	0.0513	7.6
3700	3120DE372T100AM	DE	0.0440	8.7
4400	3120DF442T100AM	DF	0.0385	9.7
5000	3120DG502T100AM	DG	0.0347	10.7
5600	3120DH562T100AM	DH	0.0317	11.6
1600	3120EA162T100AM	EA	0.1295	4.3
2400	3120EB242T100AM	EB	0.0883	5.6
3200	3120EC322T100AM	EC	0.0678	6.8
4000	3120ED402T100AM	ED	0.0555	7.9
4800	3120EE482T100AM	EE	0.0474	9.0
5700	3120EF572T100AM	EF	0.0416	10.1
6500	3120EG652T100AM	EG	0.0374	11.1
7300	3120EH732T100AM	EH	0.0341	12.1
3500	3120FB352T100AM	FB	0.1100	5.8
4700	3120FC472T100AM	FC	0.0842	7.0
5900	3120FD592T100AM	FD	0.0688	8.2
7100	3120FE712T100AM	FE	0.0586	9.3
8300	3120FF832T100AM	FF	0.0513	10.4
9400	3120FG942T100AM	FG	0.0460	11.4
10000	3120FH103T100AM	FH	0.0421	12.4
7000	3120GC702T100AM	GC	0.0368	11.9
8700	3120GD872T100AM	GD	0.0304	13.8
10000	3120GE103T100AM	GE	0.0263	15.5
12000	3120GF123T100AM	GF	0.0232	17.3
14000	3120GG143T100AM	GG	0.0209	19.0
15000	3120GH153T100AM	GH	0.0193	20.4
25000	3120GN253T100DM	GN	0.0142	28.4

SERIES 3120

125.0 VDC WORKING 150.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
620	3120BA621T125AM	BA	0.1209	3.5
740	3120BB741T125AM	BB	0.1022	4.1
990	3120BC991T125AM	BC	0.0782	5.0
1200	3120BD122T125AM	BD	0.0652	5.9
1400	3120BE142T125AM	BE	0.0566	6.6
1700	3120BF172T125AM	BF	0.0476	7.6
1900	3120BG192T125AM	BG	0.0431	8.4
2200	3120BH222T125AM	BH	0.0385	9.2
1100	3120DA112T125AM	DA	0.1021	4.4
1300	3120DB132T125AM	DB	0.0866	5.2
1800	3120DC182T125AM	DC	0.0655	6.3
2200	3120DD222T125AM	DD	0.0541	7.4
2700	3120DE272T125AM	DE	0.0459	8.5
3100	3120DF312T125AM	DF	0.0406	9.5
3600	3120DG362T125AM	DG	0.0362	10.5
4000	3120DH402T125AM	DH	0.0332	11.4
1100	3120EA112T125AM	EA	0.1315	4.2
1700	3120EB172T125AM	EB	0.0889	5.5
2300	3120EC232T125AM	EC	0.0679	6.8
2900	3120ED292T125AM	ED	0.0555	7.9
3500	3120EE352T125AM	EE	0.0474	9.0
4100	3120EF412T125AM	EF	0.0416	10.1
4700	3120EG472T125AM	EG	0.0373	11.1
5300	3120EH532T125AM	EH	0.0341	12.1
2900	3120FB292T125AM	FB	0.1112	5.7
3900	3120FC392T125AM	FC	0.0850	7.0
4900	3120FD492T125AM	FD	0.0694	8.1
5900	3120FE592T125AM	FE	0.0591	9.3
6900	3120FF692T125AM	FF	0.0518	10.3
7800	3120FG782T125AM	FG	0.0464	11.4
8800	3120FH882T125AM	FH	0.0423	12.4
5800	3120GC582T125AM	GC	0.0374	11.8
7200	3120GD722T125AM	GD	0.0309	13.7
8700	3120GE872T125AM	GE	0.0265	15.5
10000	3120GF103T125AM	GF	0.0235	17.2
11000	3120GG113T125AM	GG	0.0213	18.7
13000	3120GH133T125AM	GH	0.0194	20.4
21000	3120GN213T125DM	GN	0.0143	28.3

150.0 VDC WORKING 200.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
560	3120BA561T150AM	BA	0.1261	3.4
680	3120BB681T150AM	BB	0.1054	4.0
930	3120BC931T150AM	BC	0.0814	4.9
1100	3120BD112T150AM	BD	0.0689	5.7
1400	3120BE142T150AM	BE	0.0567	6.6
1600	3120BF162T150AM	BF	0.0494	7.5
1800	3120BG182T150AM	BG	0.0446	8.2
2000	3120BH202T150AM	BH	0.0407	9.0
1000	3120DA102T150AM	DA	0.1049	4.3
1200	3120DB122T150AM	DB	0.0884	5.1
1700	3120DC172T150AM	DC	0.0695	6.2
2100	3120DD212T150AM	DD	0.0571	7.2
2500	3120DE252T150AM	DE	0.0489	8.2
2900	3120DF292T150AM	DF	0.0430	9.2
3400	3120DG342T150AM	DG	0.0382	10.2
3800	3120DH382T150AM	DH	0.0349	11.1
1000	3120EA102T150AM	EA	0.1344	4.2
1600	3120EB162T150AM	EB	0.0898	5.5
2200	3120EC222T150AM	EC	0.0724	6.6
2700	3120ED272T150AM	ED	0.0595	7.7
3300	3120EE332T150AM	EE	0.0505	8.7
3800	3120EF382T150AM	EF	0.0445	9.8
4400	3120EG442T150AM	EG	0.0398	10.8
4900	3120EH492T150AM	EH	0.0363	11.7
2600	3120FB262T150AM	FB	0.1125	5.7
3700	3120FC372T150AM	FC	0.0918	6.7
4600	3120FD462T150AM	FD	0.0750	7.8
5500	3120FE552T150AM	FE	0.0638	8.9
6400	3120FF642T150AM	FF	0.0559	10.0
7400	3120FG742T150AM	FG	0.0499	11.0
8300	3120FH832T150AM	FH	0.0453	12.0
5400	3120GC542T150AM	GC	0.0402	11.4
6800	3120GD682T150AM	GD	0.0330	13.2
8200	3120GE822T150AM	GE	0.0283	15.0
9500	3120GF952T150AM	GF	0.0250	16.6
10000	3120GG103T150AM	GG	0.0229	18.1
11000	3120GH113T150AM	GH	0.0199	20.1
20000	3120GN203T150DM	GN	0.0151	27.6

200.0 VDC WORKING 250.0 SURGE

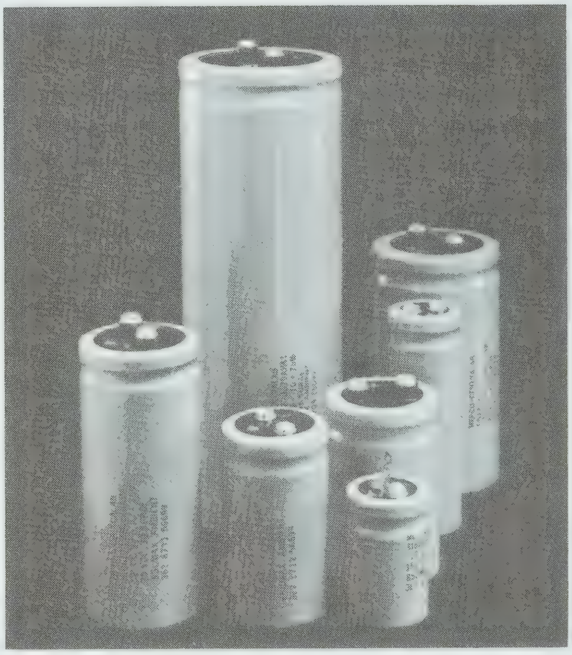
CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
420	3120BA421T200AM	BA	0.1247	3.4
500	3120BB501T200AM	BB	0.1055	4.0
690	3120BC691T200AM	BC	0.0812	4.9
870	3120BD871T200AM	BD	0.0661	5.8
1000	3120BE102T200AM	BE	0.0578	6.6
1100	3120BF112T200AM	BF	0.0516	7.3
1300	3120BG132T200AM	BG	0.0452	8.2
1500	3120BH152T200AM	BH	0.0404	9.0
770	3120DA771T200AM	DA	0.1032	4.4
920	3120DB921T200AM	DB	0.0871	5.1
1200	3120DC122T200AM	DC	0.0708	6.1
1500	3120DD152T200AM	DD	0.0579	7.2
1900	3120DE192T200AM	DE	0.0484	8.3
2200	3120DF222T200AM	DF	0.0427	9.2
2500	3120DG252T200AM	DG	0.0383	10.2
2800	3120DH282T200AM	DH	0.0350	11.1
790	3120EA791T200AM	EA	0.1316	4.2
1100	3120EB112T200AM	EB	0.0918	5.5
1600	3120EC162T200AM	EC	0.0727	6.5
2000	3120ED202T200AM	ED	0.0595	7.7
2400	3120EE242T200AM	EE	0.0507	8.7
2800	3120EF282T200AM	EF	0.0445	9.8
3300	3120EG332T200AM	EG	0.0396	10.8
3700	3120EH372T200AM	EH	0.0362	11.8
2000	3120FB202T200AM	FB	0.1119	5.7
2700	3120FC272T200AM	FC	0.0921	6.7
3400	3120FD342T200AM	FD	0.0751	7.8
4100	3120FE412T200AM	FE	0.0638	8.9
4800	3120FF482T200AM	FF	0.0558	10.0
5500	3120FG552T200AM	FG	0.0204	17.2
6200	3120FH622T200AM	FH	0.0187	18.6
4000	3120GC402T200AM	GC	0.0402	11.4
5000	3120GD502T200AM	GD	0.0331	13.2
6100	3120GE612T200AM	GE	0.0283	15.0
7100	3120GF712T200AM	GF	0.0250	16.7
8100	3120GG812T200AM	GG	0.0225	18.3
9100	3120GH912T200AM	GH	0.0206	19.8
14000	3120GN143T200DM	GN	0.0152	27.5

250.0 VDC WORKING 300.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
330	3120BA331T250AM	BA	0.1381	3.2
390	3120BB391T250AM	BB	0.1173	3.8
540	3120BC541T250AM	BC	0.0898	4.7
680	3120BD681T250AM	BD	0.0730	5.5
810	3120BE811T250AM	BE	0.0624	6.3
930	3120BF931T250AM	BF	0.0541	7.1
1000	3120BG102T250AM	BG	0.0501	7.8
1100	3120BH112T250AM	BH	0.0451	8.5
600	3120DA601T250AM	DA	0.1114	4.2
720	3120DB721T250AM	DB	0.0938	5.0
990	3120DC991T250AM	DC	0.0743	6.0
1200	3120DD122T250AM	DD	0.0615	6.9
1400	3120DE142T250AM	DE	0.0530	7.9
1700	3120DF172T250AM	DF	0.0457	8.9
1900	3120DG192T250AM	DG	0.0413	9.8
2200	3120DH222T250AM	DH	0.0371	10.7
620	3120EA621T250AM	EA	0.1393	4.1
930	3120EB931T250AM	EB	0.0948	5.4
1200	3120EC122T250AM	EC	0.0777	6.3
1600	3120ED162T250AM	ED	0.0622	7.5
1900	3120EE192T250AM	EE	0.0531	8.5
2200	3120EF222T250AM	EF	0.0467	9.5
2500	3120EG252T250AM	EG	0.0419	10.5
2900	3120EH292T250AM	EH	0.0378	11.5
1500	3120FB152T250AM	FB	0.1158	5.6
2100	3120FC212T250AM	FC	0.0945	6.6
2700	3120FD272T250AM	FD	0.0767	7.7
3200	3120FE322T250AM	FD	0.0271	13.7
3700	3120FF372T250AM	FF	0.0240	15.2
4300	3120FG432T250AM	FG	0.0215	16.7
4800	3120FH482T250AM	FH	0.0197	18.1
3100	3120GC312T250AM	GC	0.0418	11.2
3900	3120GD392T250AM	GD	0.0343	13.0
4700	3120GE472T250AM	GE	0.0294	14.7
5500	3120GF552T250AM	GF	0.0259	16.4
6300	3120GG632T250AM	GG	0.0233	17.9
7100	3120GH712T250AM	GH	0.0213	19.5
11000	3120GN113T250DM	GN	0.0156	27.1

SERIES 3186
Computer Grade Capacitors

Computer-Grade Aluminum Electrolytic Capacitors



DESCRIPTION:
Philips Components' Series 3186 Computer-Grade Aluminum Electrolytic Capacitors are designed for use in the most demanding data-system and industrial-control applications. They provide the highest attainable reliability in this class of capacitors, with generous safety margins insured by computer designing and painstaking manufacturing control.

This family of capacitors offers the widest range of capacity/voltage combinations ever offered in heavy-duty computer-grade electrolytics. Combined with 39 standard case sizes and five terminal options, the Series 3186 Capacitors can provide a suitable standard product for nearly every application. In addition, the ripple-current ratings for these units meet or exceed all industry requirements for similar products. These capacitors are suitable for all applications where long life at high operating temperatures without derating is required in a standard computer-grade product.

FEATURES:
- 1000 Hours Operating Life at 85°C with ripple.
- Highest Capacitance per case size.
- Meets or exceeds all requirements for EIA-RS395 for type II capacitors.
- Computer-designed for optimum performance.
- Three Standard Insulation Thicknesses.
- 39 Standard Case Sizes.
- Pressure-Sensitive Safety Vent.

6.5 VDC WORKING 9 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
51000	3186BA513U6P5AM	BA	0.0147	7.0
61000	3186BB613U6P5AM	BB	0.0128	8.2
82000	3186BC823U6P5AM	BC	0.0104	9.8
100000	3186BD104U6P5AM	BD	0.0090	11.1
110000	3186BE114U6P5AM	BE	0.0090	11.8
130000	3186BF134U6P5AM	BF	0.0082	12.9
150000	3186BG154U6P5AM	BG	0.0077	14.0
180000	3186BH184U6P5AM	BH	0.0067	15.6
91000	3186DA913U6P5AM	DA	0.1153	8.0
100000	3186DB104U6P5AM	DB	0.0134	9.3
140000	3186DC144U6P5AM	DC	0.0109	11.0
180000	3186DD184U6P5AM	DD	0.0094	12.5
210000	3186DE214U6P5AM	DE	0.0085	13.9
250000	3186DF254U6P5AM	DF	0.0079	15.2
290000	3186DG294U6P5AM	DG	0.0074	16.4
320000	3186DH324U6P5AM	DH	0.0071	17.4
110000	3186EA114U6P5AM	EA	0.0080	12.2
130000	3186EB134U6P5AM	EB	0.0081	13.8
180000	3186EC184U6P5AM	EC	0.0074	14.5
230000	3186ED234U6P5AM	ED	0.0065	16.4
260000	3186EE264U6P5AM	EE	0.0053	19.1
330000	3186EF334U6P5AM	EF	0.0054	19.7
370000	3186EG374U6P5AM	EG	0.0052	21.2
420000	3186EH424U6P5AM	EH	0.0049	22.5
230000	3186FB234U6P5AM	FB	0.0060	17.4
310000	3186FC314U6P5AM	FC	0.0051	20.2
390000	3186FD394U6P5AM	FD	0.0045	22.5
470000	3186FE474U6P5AM	FE	0.0042	24.7
550000	3186FF554U6P5AM	FF	0.0039	26.6
630000	3186FG634U6P5AM	FG	0.0037	28.3
710000	3186FH714U6P5AM	FH	0.0036	30.0
460000	3186GC464U6P5AM	GC	0.0041	25.4
580000	3186GD584U6P5AM	GD	0.0037	28.1
690000	3186GE694U6P5DM	GE	0.0034	30.5
810000	3186GF814U6P5DM	GF	0.0032	32.8
930000	3186GG934U6P5DM	GG	0.0031	34.8
1000000	3186GH105U6P5DM	GH	0.0030	36.6

7.5 VDC WORKING 9 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
46000	3188BA463U7P5AM	BA	0.0148	7.0
56000	3186BB563U7P5AM	BB	0.0128	8.2
74000	3186BC743U7P5AM	BC	0.0105	9.7
93000	3186BD933U7P5AM	BD	0.0091	11.1
100000	3186BE104U7P5AM	BE	0.0090	11.8
120000	3186BF124U7P5AM	BF	0.0083	12.9
140000	3186BG144U7P5AM	BG	0.0071	14.5
160000	3186BH164U7P5AM	BH	0.0068	15.5
83000	3186DA833U7P5AM	DA	0.0154	8.0
99000	3186DB993U7P5AM	DB	0.0134	9.3
130000	3186DC134U7P5AM	DC	0.0109	11.0
160000	3186DD164U7P5AM	DD	0.0095	12.5
190000	3186DE194U7P5AM	DE	0.0086	13.9
230000	3186DF234U7P5AM	DF	0.0079	15.2
260000	3186DG264U7P5AM	DG	0.0074	16.3
290000	3186DH294U7P5AM	DH	0.0071	17.4
100000	3186EA104U7P5AM	EA	0.0080	12.1
120000	3186EB124U7P5AM	EB	0.0071	13.9
160000	3186EC164U7P5AM	EC	0.0089	13.2
210000	3186ED214U7P5AM	ED	0.0065	16.4
250000	3186EE254U7P5AM	EE	0.0059	18.1
280000	3186EF284U7P5AM	EF	0.0063	18.3
340000	3186EG344U7P5AM	EG	0.0052	21.1
380000	3186EH384U7P5AM	EH	0.0050	22.4
210000	3186FB214U7P5AM	FB	0.0061	17.4
280000	3186FC284U7P5AM	FC	0.0051	20.1
350000	3186FD354U7P5AM	FD	0.0045	22.5
430000	3186FE434U7P5AM	FE	0.0042	24.6
500000	3186FF504U7P5AM	FF	0.0039	26.5
570000	3186FG574U7P5AM	FG	0.0038	28.3
640000	3186FH644U7P5AM	FH	0.0036	29.9
420000	3186GC424U7P5AM	GC	0.0041	25.3
530000	3186GD534U7P5AM	GD	0.0037	28.1
630000	3186GE634U7P5DM	GE	0.0034	30.5
740000	3186GF744U7P5DM	GF	0.0032	32.7
840000	3186GG844U7P5DM	GG	0.0031	34.7
950000	3186GH954U7P5DM	GH	0.0030	36.6

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10.0 VDC WORKING 12.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
41000	3186BA413U010AM	BA	0.0149	7.0
49000	3186BB493U010AM	BB	0.0130	8.1
65000	3186BC653U010AM	BC	0.0105	9.7
82000	3186BD823U010AM	BD	0.0091	11.1
98000	3186BE983U010AM	BE	0.0082	12.3
110000	3186BF114U010AM	BF	0.0145	9.7
120000	3186BG124U010AM	BG	0.0077	13.9
140000	3186BH144U010AM	BH	0.0128	11.3
73000	3186DA733U010AM	DA	0.0155	8.0
87000	3186DB873U010AM	DB	0.0135	9.3
110000	3186DC114U010AM	DC	0.0110	10.9
140000	3186DD144U010AM	DD	0.0095	12.5
170000	3186DE174U010AM	DE	0.0086	13.9
200000	3186DF204U010AM	DF	0.0079	15.1
230000	3186DG234U010AM	DG	0.0075	16.3
260000	3186DH264U010AM	DH	0.0071	17.4
94000	3186EA943U010AM	EA	0.0080	12.1
110000	3186EB114U010AM	EB	0.0071	13.9
140000	3186EC144U010AM	EC	0.0090	13.2
180000	3186ED184U010AM	ED	0.0065	16.3
220000	3186EE224U010AM	EE	0.0059	18.1
250000	3186EF254U010AM	EF	0.0063	18.3
290000	3186EG294U010AM	EG	0.0059	19.7
340000	3186EH344U010AM	EH	0.0050	22.4
180000	3186FB184U010AM	FB	0.0076	15.5
250000	3186FC254U010AM	FC	0.0063	18.0
310000	3186FD314U010AM	FD	0.0056	20.3
370000	3186FE374U010AM	FE	0.0051	22.3
440000	3186FF444U010AM	FF	0.0048	24.1
500000	3186FG504U010AM	FG	0.0045	25.8
560000	3186FH564U010AM	FH	0.0043	27.4
370000	3186GC374U010AM	GC	0.0047	23.6
460000	3186GD464U010AM	GD	0.0042	26.3
550000	3186GE554U010AM	GE	0.0039	28.7
650000	3186GF654U010DM	GF	0.0036	30.8
740000	3186GG744U010DM	GG	0.0035	32.8
830000	3186GH834U010DM	GH	0.0034	34.6

15.0 VDC WORKING 18.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
30000	3186BA303U015AM	BA	0.0309	4.9
36000	3186BB363U015AM	BB	0.0266	5.7
48000	3186BC483U015AM	BC	0.0212	6.8
60000	3186BD603U015AM	BD	0.0181	7.9
72000	3186BE723U015AM	BE	0.0161	8.8
84000	3186BF843U015AM	BF	0.0147	9.7
97000	3186BG973U015AM	BG	0.0136	10.5
100000	3186BH104U015AM	BH	0.0129	11.2
53000	3186DA533U015AM	DA	0.0158	7.9
64000	3186DB643U015AM	DB	0.0137	9.2
86000	3186DC863U015AM	DC	0.0111	10.9
100000	3186DD104U015AM	DD	0.0097	12.4
120000	3186DE124U015AM	DE	0.0087	13.8
150000	3186DF154U015AM	DF	0.0080	15.1
170000	3186DG174U015AM	DG	0.0075	16.2
190000	3186DH194U015AM	DH	0.0072	17.3
69000	3186EA693U015AM	EA	0.0082	12.0
83000	3186EB833U015AM	EB	0.0092	12.2
110000	3186EC114U015AM	EC	0.0121	11.4
130000	3186ED134U015AM	ED	0.0104	12.9
160000	3186EE164U015AM	EE	0.0093	14.4
190000	3186EF194U015AM	EF	0.0085	15.8
220000	3186EG224U015AM	EG	0.0080	17.0
250000	3186EH254U015AM	EH	0.0050	22.3
130000	3186FB134U015AM	FB	0.0078	15.3
180000	3186FC184U015AM	FC	0.0064	17.9
230000	3186FD234U015AM	FD	0.0056	20.2
270000	3186FE274U015AM	FE	0.0052	22.2
320000	3186FF324U015AM	FF	0.0048	24.0
370000	3186FG374U015AM	FG	0.0045	25.7
410000	3186FH414U015AM	FH	0.0044	27.2
270000	3186GC274U015AM	GC	0.0057	21.4
340000	3186GD344U015AM	GD	0.0050	24.0
410000	3186GE414U015AM	GE	0.0046	26.3
480000	3186GF484U015AM	GF	0.0043	28.4
540000	3186GG544U015DM	GG	0.0041	30.3
610000	3186GH614U015DM	GH	0.0039	32.0

20.0 VDC WORKING 24.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
25000	3186BA253U020AM	BA	0.0312	4.8
30000	3186BB303U020AM	BB	0.0268	5.7
41000	3186BC413U020AM	BC	0.0273	6.0
51000	3186BD513U020AM	BD	0.0182	7.8
61000	3186BE613U020AM	BE	0.0162	8.8
72000	3186BF723U020AM	BF	0.0147	9.7
82000	3186BG823U020AM	BG	0.0137	10.5
92000	3186BH923U020AM	BH	0.0130	11.2
45000	3186DA453U020AM	DA	0.0159	7.9
55000	3186DB553U020AM	DB	0.0138	9.2
73000	3186DC733U020AM	DC	0.0112	10.8
91000	3186DD913U020AM	DD	0.0097	12.4
110000	3186DE114U020AM	DE	0.0105	12.6
120000	3186DF124U020AM	DF	0.0081	15.0
140000	3186DG144U020AM	DG	0.0089	14.9
160000	3186DH164U020AM	DH	0.0084	16.0
59000	3186EA593U020AM	EA	0.0174	8.2
71000	3186EB713U020AM	EB	0.0150	9.5
95000	3186EC953U020AM	EC	0.0121	11.3
110000	3186ED114U020AM	ED	0.0105	12.9
140000	3186EE144U020AM	EE	0.0094	14.4
160000	3186EF164U020AM	EF	0.0086	15.7
190000	3186EG194U020AM	EG	0.0080	17.0
210000	3186EH214U020AM	EH	0.0076	18.1
110000	3186FB114U020AM	FB	0.0111	12.8
150000	3186FC154U020AM	FC	0.0065	17.8
190000	3186FD194U020AM	FD	0.0057	20.1
230000	3186FE234U020AM	FE	0.0052	22.1
270000	3186FF274U020AM	FF	0.0048	24.0
310000	3186FG314U020AM	FG	0.0046	25.6
350000	3186FH354U020AM	FH	0.0044	27.2
230000	3186GC234U020AM	GC	0.0057	21.3
290000	3186GD294U020AM	GD	0.0051	23.9
350000	3186GE354U020AM	GE	0.0046	26.2
400000	3186GF404U020AM	GF	0.0043	28.3
460000	3186GG464U020DM	GG	0.0041	30.2
520000	3186GH524U020DM	GH	0.0039	32.0

25.0 VDC WORKING 30.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
20000	3186BA203U025AM	BA	0.0412	4.2
24000	3186BB243U025AM	BB	0.0352	4.9
32000	3186BC323U025AM	BC	0.0217	6.8
40000	3186BD403U025AM	BD	0.0185	7.8
48000	3186BE483U025AM	BE	0.0164	8.7
56000	3186BF563U025AM	BF	0.0149	9.6
64000	3186BG643U025AM	BG	0.0139	10.4
72000	3186BH723U025AM	BH	0.0131	11.2
35000	3186DA353U025AM	DA	0.0161	7.8
42000	3186DB423U025AM	DB	0.0140	9.1
57000	3186DC573U025AM	DC	0.0114	10.8
71000	3186DD713U025AM	DD	0.0098	12.3
85000	3186DE853U025AM	DE	0.0088	13.7
100000	3186DF104U025AM	DF	0.0096	13.7
110000	3186DG114U025AM	DG	0.0090	14.8
120000	3186DH124U025AM	DH	0.0073	17.1
46000	3186EA463U025AM	EA	0.0176	8.2
55000	3186EB553U025AM	EB	0.0152	9.5
74000	3186EC743U025AM	EC	0.0123	11.2
92000	3186ED923U025AM	ED	0.0106	12.8
110000	3186EE114U025AM	EE	0.0095	14.3
120000	3186EF124U025AM	EF	0.0087	15.6
140000	3186EG144U025AM	EG	0.0081	16.9
160000	3186EH164U025AM	EH	0.0077	18.0
92000	3186FB923U025AM	FB	0.0112	12.8
120000	3186FC124U025AM	FC	0.0091	15.0
150000	3186FD154U025AM	FD	0.0079	17.1
180000	3186FE184U025AM	FE	0.0071	18.9
210000	3186FF214U025AM	FF	0.0065	20.6
240000	3186FG244U025AM	FG	0.0061	22.1
270000	3186FH274U025AM	FH	0.0058	23.6
180000	3186GC184U025AM	GC	0.0071	19.1
220000	3186GD224U025AM	GD	0.0066	21.0
270000	3186GE274U025AM	GE	0.0047	26.1
310000	3186GF314U025AM	GF	0.0044	28.2
360000	3186GG364U025DM	GG	0.0041	30.1
410000	3186GH414U025DM	GH	0.0040	31.9
650000	3186GN654U025DM	GN	0.0039	38.3

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30.0 VDC WORKING 40.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
13000	3186BA133U030AM	BA	0.0438	4.1
16000	3186BB163U030AM	BB	0.0373	4.8
21000	3186BC213U030AM	BC	0.0293	5.8
26000	3186BD263U030AM	BD	0.0246	6.7
32000	3186BE323U030AM	BE	0.0214	7.6
37000	3186BF373U030AM	BF	0.0193	8.5
42000	3186BG423U030AM	BG	0.0177	9.2
48000	3186BH483U030AM	BH	0.0165	10.0
23000	3186DA233U030AM	DA	0.0215	6.8
28000	3186DB283U030AM	DB	0.0185	7.9
37000	3186DC373U030AM	DC	0.0147	9.5
47000	3186DD473U030AM	DD	0.0125	10.9
56000	3186DE563U030AM	DE	0.0111	12.2
66000	3186DF663U030AM	DF	0.0101	13.4
75000	3186DG753U030AM	DG	0.0093	14.6
85000	3186DH853U030AM	DH	0.0088	15.6
30000	3186EA303U030AM	EA	0.0246	6.9
36000	3186EB363U030AM	EB	0.0210	8.1
49000	3186EC493U030AM	EC	0.0166	9.7
61000	3186ED613U030AM	ED	0.0140	11.1
73000	3186EE733U030AM	EE	0.0123	12.5
85000	3186EF853U030AM	EF	0.0112	13.8
98000	3186EG983U030AM	EG	0.0103	15.0
110000	3186EH114U030AM	EH	0.0096	16.1
61000	3186FB613U030AM	FB	0.0154	10.9
81000	3186FC813U030AM	FC	0.0123	13.0
100000	3186FD104U030AM	FD	0.0104	14.8
120000	3186FE124U030AM	FE	0.0092	16.6
140000	3186FF144U030AM	FF	0.0084	18.2
160000	3186FG164U030AM	FG	0.0077	19.7
180000	3186FH184U030AM	FH	0.0072	21.2
120000	3186GC124U030AM	GC	0.0075	18.7
150000	3186GD154U030AM	GD	0.0065	21.2
180000	3186GE184U030AM	GE	0.0058	23.4
210000	3186GF214U030AM	GF	0.0053	25.5
240000	3186GG244U030AM	GG	0.0050	27.4
270000	3186GH274U030AM	GH	0.0047	29.2
430000	3186GN434U030DM	GN	0.0040	37.8

35.0 VDC WORKING 45.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
11000	3186BA113U035AM	BA	0.0443	4.1
13000	3186BB133U035AM	BB	0.0378	4.8
18000	3186BC183U035AM	BC	0.0296	5.8
23000	3186BD233U035AM	BD	0.0247	6.7
27000	3186BE273U035AM	BE	0.0216	7.6
32000	3186BF323U035AM	BF	0.0194	8.4
36000	3186BG363U035AM	BG	0.0178	9.2
41000	3186BH413U035AM	BH	0.0166	9.9
20000	3186DA203U035AM	DA	0.0217	6.7
24000	3186DB243U035AM	DB	0.0187	7.9
32000	3186DC323U035AM	DC	0.0149	9.4
40000	3186DD403U035AM	DD	0.0126	10.8
48000	3186DE483U035AM	DE	0.0112	12.2
56000	3186DF563U035AM	DF	0.0101	13.4
65000	3186DG653U035AM	DG	0.0094	14.5
73000	3186DH733U035AM	DH	0.0088	15.6
26000	3186EA263U035AM	EA	0.0248	6.9
31000	3186EB313U035AM	EB	0.0212	8.0
42000	3186EC423U035AM	EC	0.0168	9.6
52000	3186ED523U035AM	ED	0.0142	11.1
63000	3186EE633U035AM	EE	0.0124	12.5
73000	3186EF733U035AM	EF	0.0112	13.7
84000	3186EG843U035AM	EG	0.0103	14.9
94000	3186EH943U035AM	EH	0.0097	16.1
52000	3186FB523U035AM	FB	0.0155	10.8
70000	3186FC703U035AM	FC	0.0124	12.9
87000	3186FD873U035AM	FD	0.0105	14.8
100000	3186FE104U035AM	FE	0.0093	16.5
120000	3186FF124U035AM	FF	0.0084	18.2
140000	3186FG144U035AM	FG	0.0078	19.7
150000	3186FH154U035AM	FH	0.0073	21.1
100000	3186GC104U035AM	GC	0.0102	16.0
120000	3186GD124U035AM	GD	0.0087	18.2
150000	3186GE154U035AM	GE	0.0077	20.3
180000	3186GF184U035AM	GF	0.0070	22.2
200000	3186GG204U035AM	GG	0.0065	24.0
230000	3186GH234U035AM	GH	0.0061	25.7
370000	3186GN374U035DM	GN	0.0050	33.8

40.0 VDC WORKING 50.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
9800	3186BA982U040AM	BA	0.0447	4.0
11000	3186BB113U040AM	BB	0.0383	4.7
15000	3186BC153U040AM	BC	0.0300	5.7
19000	3186BD193U040AM	BD	0.0251	6.7
23000	3186BE233U040AM	BE	0.0218	7.6
27000	3186BF273U040AM	BF	0.0196	8.4
31000	3186BG313U040AM	BG	0.0180	9.2
35000	3186BH353U040AM	BH	0.0167	9.9
17000	3186DA173U040AM	DA	0.0220	6.7
20000	3186DB203U040AM	DB	0.0189	7.8
27000	3186DC273U040AM	DC	0.0151	9.4
34000	3186DD343U040AM	DD	0.0128	10.8
41000	3186DE413U040AM	DE	0.0113	12.1
48000	3186DF483U040AM	DF	0.0102	13.3
55000	3186DG553U040AM	DG	0.0095	14.5
62000	3186DH623U040AM	DH	0.0089	15.5
22000	3186EA223U040AM	EA	0.0250	6.9
27000	3186EB273U040AM	EB	0.0214	8.0
36000	3186EC363U040AM	EC	0.0169	9.6
45000	3186ED453U040AM	ED	0.0143	11.1
54000	3186EE543U040AM	EE	0.0125	12.4
63000	3186EF633U040AM	EF	0.0113	13.7
72000	3186EG723U040AM	EG	0.0104	14.9
81000	3186EH813U040AM	EH	0.0097	16.0
45000	3186FB453U040AM	FB	0.0157	10.8
60000	3186FC603U040AM	FC	0.0125	12.9
75000	3186FD753U040AM	FD	0.0106	14.7
90000	3186FE903U040AM	FE	0.0093	16.5
100000	3186FF104U040AM	FF	0.0085	18.1
120000	3186FG124U040AM	FG	0.0078	19.6
130000	3186FH134U040AM	FH	0.0073	21.0
88000	3186GC883U040AM	GC	0.0103	15.9
110000	3186GD114U040AM	GD	0.0088	18.2
130000	3186GE134U040AM	GE	0.0078	20.2
150000	3186GF154U040AM	GF	0.0071	22.2
170000	3186GG174U040AM	GG	0.0065	23.9
190000	3186GH194U040AM	GH	0.0061	25.6
320000	3186GN324U040DM	GN	0.0050	33.7

50.0 VDC WORKING 65.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
7700	3186BA772U050AM	BA	0.0455	4.0
9300	3186BB932U050AM	BB	0.0387	4.7
12000	3186BC123U050AM	BC	0.0305	5.7
15000	3186BD153U050AM	BD	0.0255	6.6
18000	3186BE183U050AM	BE	0.0222	7.5
21000	3186BF213U050AM	BF	0.0199	8.3
24000	3186BG243U050AM	BG	0.0182	9.1
28000	3186BH283U050AM	BH	0.0169	9.8
13000	3186DA133U050AM	DA	0.0659	3.9
16000	3186DB163U050AM	DB	0.0557	4.6
22000	3186DC223U050AM	DC	0.0153	9.3
27000	3186DD273U050AM	DD	0.0130	10.7
33000	3186DE333U050AM	DE	0.0115	12.0
38000	3186DF383U050AM	DF	0.0104	13.2
44000	3186DG443U050AM	DG	0.0096	14.4
49000	3186DH493U050AM	DH	0.0090	15.4
17000	3186EA173U050AM	EA	0.0254	6.8
21000	3186EB213U050AM	EB	0.0217	7.9
28000	3186EC283U050AM	EC	0.0172	9.5
35000	3186ED353U050AM	ED	0.0145	11.0
42000	3186EE423U050AM	EE	0.0127	12.3
50000	3186EF503U050AM	EF	0.0114	13.6
57000	3186EG573U050AM	EG	0.0105	14.8
64000	3186EH643U050AM	EH	0.0098	15.9
35000	3186FB353U050AM	FB	0.0159	10.7
47000	3186FC473U050AM	FC	0.0126	12.8
59000	3186FD593U050AM	FD	0.0107	14.7
71000	3186FE713U050AM	FE	0.0094	16.4
83000	3186FF833U050AM	FF	0.0085	18.0
95000	3186FG953U050AM	FG	0.0079	19.5
100000	3186FH104U050AM	FH	0.0074	20.9
70000	3186GC703U050AM	GC	0.0104	15.9
87000	3186GD873U050AM	GD	0.0089	18.1
100000	3186GE104U050AM	GE	0.0078	20.1
120000	3186GF124U050AM	GF	0.0071	22.1
140000	3186GG144U050AM	GG	0.0066	23.9
150000	3186GH154U050AM	GH	0.0062	25.5
250000	3186GN254U050DM	GN	0.0051	33.6

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63.0 VDC WORKING 85.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
4900	3186BA492U063AM	BA	0.0477	3.9
5900	3186BB592U063AM	BB	0.0406	4.6
7900	3186BC792U063AM	BC	0.0317	5.6
9800	3186BD982U063AM	BD	0.0265	6.5
11000	3186BE113U063AM	BE	0.0233	7.3
13000	3186BF133U063AM	BF	0.0208	8.1
15000	3186BG153U063AM	BG	0.0190	8.9
17000	3186BH173U063AM	BH	0.0176	9.6
8700	3186DA872U063AM	DA	0.0674	3.8
10000	3186DB103U063AM	DB	0.0572	4.5
14000	3186DC143U063AM	DC	0.0442	5.5
17000	3186DD173U063AM	DD	0.0366	6.4
21000	3186DE213U063AM	DE	0.0315	7.2
24000	3186DF243U063AM	DF	0.0280	8.0
28000	3186DG283U063AM	DG	0.0254	8.8
31000	3186DH313U063AM	DH	0.0234	9.6
11000	3186EA113U063AM	EA	0.0264	6.7
13000	3186EB133U063AM	EB	0.0226	7.8
18000	3186EC183U063AM	EC	0.0178	9.4
22000	3186ED223U063AM	ED	0.0150	10.8
27000	3186EE273U063AM	EE	0.0131	12.1
31000	3186EF313U063AM	EF	0.0118	13.4
36000	3186EG363U063AM	EG	0.0108	14.6
40000	3186EH403U063AM	EH	0.0101	15.7
18000	3186FB183U063AM	FB	0.0273	8.2
24000	3186FC243U063AM	FC	0.0214	9.8
30000	3186FD303U063AM	FD	0.0179	11.3
36000	3186FE363U063AM	FE	0.0156	12.7
42000	3186FF423U063AM	FF	0.0139	14.1
48000	3186FG483U063AM	FG	0.0127	15.4
54000	3186FH543U063AM	FH	0.0118	16.6
35000	3186GC353U063AM	GC	0.0147	13.3
44000	3186GD443U063AM	GD	0.0124	15.3
53000	3186GE533U063AM	GE	0.0108	17.1
62000	3186GF623U063AM	GF	0.0098	18.8
71000	3186GG713U063AM	GG	0.0090	20.4
80000	3186GH803U063AM	GH	0.0084	22.0
130000	3186GN134U063AM	GN	0.0067	29.3

75.0 VDC WORKING 95.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
4400	3186BA442U075AM	BA	0.0484	3.9
5300	3186BB532U075AM	BB	0.0411	4.6
7100	3186BC712U075AM	BC	0.0321	5.5
8900	3186BD892U075AM	BD	0.0268	6.5
10000	3186BE103U075AM	BE	0.0235	7.3
12000	3186BF123U075AM	BF	0.0210	8.1
14000	3186BG143U075AM	BG	0.0191	8.9
16000	3186BH163U075AM	BH	0.0177	9.6
7900	3186DA792U075AM	DA	0.0678	3.8
9500	3186DB952U075AM	DB	0.0574	4.5
12000	3186DC123U075AM	DC	0.0446	5.4
15000	3186DD153U075AM	DD	0.0369	6.3
19000	3186DE193U075AM	DE	0.0317	7.2
22000	3186DF223U075AM	DF	0.0281	8.0
25000	3186DG253U075AM	DG	0.0255	8.8
28000	3186DH283U075AM	DH	0.0235	9.6
10000	3186EA103U075AM	EA	0.0823	3.8
12000	3186EB123U075AM	EB	0.0695	4.4
16000	3186EC163U075AM	EC	0.0536	5.4
20000	3186ED203U075AM	ED	0.0441	6.3
24000	3186EE243U075AM	EE	0.0378	7.2
28000	3186EF283U075AM	EF	0.0333	8.0
32000	3186EG323U075AM	EG	0.0300	8.8
37000	3186EH373U075AM	EH	0.0102	15.7
16000	3186FB163U075AM	FB	0.0276	8.1
22000	3186FC223U075AM	FC	0.0215	9.8
27000	3186FD273U075AM	FD	0.0180	11.3
33000	3186FE333U075AM	FE	0.0157	12.7
38000	3186FF383U075AM	FF	0.0140	14.0
44000	3186FG443U075AM	FG	0.0128	15.3
49000	3186FH493U075DM	FH	0.0119	16.5
32000	3186GC323U075AM	GC	0.0278	9.7
40000	3186GD403U075AM	GD	0.0231	11.2
48000	3186GE483U075AM	GE	0.0199	12.6
57000	3186GF573U075AM	GF	0.0177	14.0
65000	3186GG653U075AM	GG	0.0160	15.3
73000	3186GH733U075AM	GH	0.0147	16.5
110000	3186GN114U075AM	GN	0.0111	22.7

100.0 VDC WORKING 125.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
2200	3186BA222U100AM	BA	0.1507	2.2
2600	3186BB262U100AM	BB	0.1279	2.6
3500	3186BC352U100AM	BC	0.0968	3.2
4400	3186BD442U100AM	BD	0.0784	3.8
5300	3186BE532U100AM	BE	0.0663	4.3
6100	3186BF612U100AM	BF	0.0584	4.9
7000	3186BG702U100AM	BG	0.0519	5.4
7900	3186BH792U100AM	BH	0.0469	5.9
3900	3186DA392U100AM	DA	0.1140	2.9
4700	3186DB472U100AM	DB	0.0959	3.5
6200	3186DC622U100AM	DC	0.0738	4.2
7800	3186DD782U100AM	DD	0.0603	5.0
9400	3186DE942U100AM	DE	0.0515	5.7
11000	3186DF113U100AM	DF	0.0452	6.3
12000	3186DG123U100AM	DG	0.0410	6.9
14000	3186DH143U100AM	DH	0.0371	7.6
5100	3186EA512U100AM	EA	0.1152	3.2
6100	3186EB612U100AM	EB	0.0971	3.8
8100	3186EC812U100AM	EC	0.0745	4.6
10000	3186ED103U100AM	ED	0.0611	5.3
12000	3186EE123U100AM	EE	0.0521	6.1
14000	3186EF143U100AM	EF	0.0458	6.8
16000	3186EG163U100AM	EG	0.0410	7.5
18000	3186EH183U100AM	EH	0.0374	8.2
10000	3186FB103U100AM	FB	0.0485	6.1
13000	3186FC133U100AM	FC	0.0375	7.4
17000	3186FD173U100AM	FD	0.0308	8.6
20000	3186FE203U100AM	FE	0.0264	9.8
23000	3186FF233U100AM	FF	0.0234	10.9
27000	3186FG273U100AM	FG	0.0210	12.0
30000	3186FH303U100AM	FH	0.0193	13.0
20000	3186GC203U100AM	GC	0.0406	8.0
25000	3186GD253U100AM	GD	0.0334	9.3
30000	3186GE303U100AM	GE	0.0287	10.5
35000	3186GF353U100AM	GF	0.0253	11.7
40000	3186GG403U100AM	GG	0.0228	12.8
45000	3186GH453U100AM	GH	0.0208	13.9
72000	3186GN723U100AM	GN	0.0152	19.4

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125.0 VDC WORKING 150.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
1100	3186BA112T125AM	BA	0.3121	1.5
1400	3186BB142T125AM	BB	0.2480	1.9
1800	3186BC182T125AM	BC	0.1935	2.3
2300	3186BD232T125AM	BD	0.1532	2.7
2800	3186BE282T125AM	BE	0.1272	3.1
3200	3186BF322T125AM	BF	0.1120	3.5
3700	3186BG372T125AM	BG	0.0980	3.9
4200	3186BH422T125AM	BH	0.0873	4.3
2100	3186DA212T125AM	DA	0.1861	2.3
2500	3186DB252T125AM	DB	0.1569	2.7
3300	3186DC332T125AM	DC	0.1201	3.3
4200	3186DD422T125AM	DD	0.0964	3.9
5000	3186DE502T125AM	DE	0.0819	4.5
5800	3186DF582T125AM	DF	0.0716	5.0
6700	3186DG672T125AM	DG	0.0632	5.6
7500	3186DH752T125AM	DH	0.0573	6.1
2700	3186EA272T125AM	EA	0.1623	2.7
3200	3186EB322T125AM	EB	0.1371	3.2
4300	3186EC432T125AM	EC	0.1041	3.9
5400	3186ED542T125AM	ED	0.0845	4.5
6500	3186EE652T125AM	EE	0.0715	5.2
7600	3186EF762T125AM	EF	0.0624	5.8
8700	3186EG872T125AM	EG	0.0555	6.4
9800	3186EH982T125AM	EH	0.0503	7.0
5400	3186FB542T125AM	FB	0.1288	3.8
7300	3186FC732T125AM	FC	0.0982	4.6
9100	3186FD912T125AM	FD	0.0800	5.4
10000	3186FE103T125AM	FE	0.0685	6.1
12000	3186FF123T125AM	FF	0.0597	6.8
14000	3186FG143T125AM	FG	0.0318	9.7
16000	3186FH163T125AM	FH	0.0286	10.6
10000	3186GC103T125AM	GC	0.0502	7.2
13000	3186GD133T125AM	GD	0.0406	8.4
16000	3186GE163T125AM	GE	0.0344	9.6
18000	3186GF183T125AM	GF	0.0305	10.7
21000	3186GG213T125AM	GG	0.0272	11.7
24000	3186GH243T125AM	GH	0.0246	12.8
39000	3186GN393T125AM	GN	0.0175	18.1

150.0 VDC WORKING 175.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
820	3186BA821T150AM	BA	0.3126	1.5
990	3186BB991T150AM	BB	0.2601	1.8
1300	3186BC132T150AM	BC	0.1992	2.2
1600	3186BD162T150AM	BD	0.1628	2.6
1900	3186BE192T150AM	BE	0.1380	3.0
2300	3186BF232T150AM	BF	0.1157	3.5
2600	3186BG262T150AM	BG	0.1031	3.8
2900	3186BH292T150AM	BH	0.0932	4.2
1400	3186DA142T150AM	DA	0.2018	2.2
1700	3186DB172T150AM	DB	0.1679	2.6
2300	3186DC232T150AM	DC	0.1264	3.2
2900	3186DD292T150AM	DD	0.1019	3.8
3500	3186DE352T150AM	DE	0.0859	4.4
4100	3186DF412T150AM	DF	0.0745	4.9
4700	3186DG472T150AM	DG	0.0661	5.5
5300	3186DH532T150AM	DH	0.0596	6.0
1900	3186EA192T150AM	EA	0.1690	2.6
2300	3186EB232T150AM	EB	0.1413	3.1
3000	3186EC302T150AM	EC	0.1088	3.8
3800	3186ED382T150AM	ED	0.0879	4.5
4600	3186EE462T150AM	EE	0.0741	5.1
5300	3186EF532T150AM	EF	0.0650	5.7
6100	3186EG612T150AM	EG	0.0577	6.3
6900	3186EH692T150AM	EH	0.0521	6.9
3800	3186FB382T150AM	FB	0.1325	3.7
5100	3186FC512T150AM	FC	0.1010	4.5
6400	3186FD642T150AM	FD	0.0823	5.3
7700	3186FE772T150AM	FE	0.0698	6.0
9000	3186FF902T150AM	FF	0.0362	8.7
10000	3186FG103T150AM	FG	0.0328	9.6
11000	3186FH113T150AM	FH	0.0301	10.4
7500	3186GC762T150AM	GC	0.0507	7.2
9500	3186GD952T150AM	GD	0.0415	8.4
11000	3186GE113T150AM	GE	0.0358	9.4
13000	3186GF133T150AM	GF	0.0312	10.5
15000	3186GG153T150AM	GG	0.0279	11.6
17000	3186GH173T150AM	GH	0.0253	12.6
27000	3186GN273T150AM	GN	0.0180	17.8

200.0 VDC WORKING 250.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
490	3186BA491T200AM	BA	0.1441	2.2
590	3186BB591T200AM	BB	0.1208	2.7
810	3186BC811T200AM	BC	0.0922	3.3
1000	3186BD102T200AM	BD	0.0757	3.8
1200	3186BE122T200AM	BE	0.0642	4.4
1400	3186BF142T200AM	BF	0.0560	5.0
1600	3186BG162T200AM	BG	0.0500	5.5
1800	3186BH182T200AM	BH	0.0453	6.0
880	3186DA881T200AM	DA	0.1048	3.1
1000	3186DB102T200AM	DB	0.0901	3.6
1400	3186DC142T200AM	DC	0.0707	4.3
1800	3186DD182T200AM	DD	0.0574	5.1
2100	3186DE212T200AM	DE	0.0495	5.8
2500	3186DF252T200AM	DF	0.0433	6.5
2900	3186DG292T200AM	DG	0.0387	7.2
3200	3186DH322T200AM	DH	0.0355	7.8
1100	3186EA112T200AM	EA	0.1046	3.4
1300	3186EB132T200AM	EB	0.0886	3.9
1800	3186EC182T200AM	EC	0.0707	4.7
2300	3186ED232T200AM	ED	0.0577	5.5
2800	3186EE282T200AM	EE	0.0491	6.3
3300	3186EF332T200AM	EF	0.0431	7.0
3700	3186EG372T200AM	EG	0.0389	7.7
4200	3186EH422T200AM	EH	0.0354	8.4
2300	3186FB232T200AM	FB	0.1025	4.2
3100	3186FC312T200AM	FC	0.0838	5.0
3900	3186FD392T200AM	FD	0.0684	5.8
4700	3186FE472T200AM	FE	0.0583	6.6
5500	3186FF552T200AM	FF	0.0224	11.1
6300	3186FG632T200AM	FG	0.0202	12.2
7100	3186FH712T200AM	FH	0.0185	13.2
4600	3186GC462T200AM	GC	0.0378	8.3
5800	3186GD582T200AM	GD	0.0311	9.6
7000	3186GE702T200AM	GE	0.0267	10.9
8100	3186GF812T200AM	GF	0.0237	12.1
9300	3186GG932T200AM	GG	0.0213	13.3
10000	3186GH103T200AM	GH	0.0197	14.3
16000	3186GN163T200AM	GN	0.0145	19.9

250.0 VDC WORKING 300.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
360	3186BA361T250AM	BA	0.1614	2.1
440	3186BB441T250AM	BB	0.1336	2.5
600	3186BC601T250AM	BC	0.1021	3.1
750	3186BD751T250AM	BD	0.0830	3.7
900	3186BE901T250AM	BE	0.0703	4.2
1000	3186BF102T250AM	BF	0.0634	4.7
1200	3186BG122T250AM	BG	0.0545	5.3
1300	3186BH132T250AM	BH	0.0506	5.7
650	3186DA651T250AM	DA	0.1148	2.9
790	3186DB791T250AM	DB	0.0962	3.5
1000	3186DC102T250AM	DC	0.0781	4.1
1300	3186DD132T250AM	DD	0.0629	4.9
1600	3186DE162T250AM	DE	0.0531	5.6
1800	3186DF182T250AM	DF	0.0472	6.2
2100	3186DG212T250AM	DG	0.0420	6.9
2400	3186DH242T250AM	DH	0.0381	7.5
850	3186EA851T250AM	EA	0.1110	3.3
1000	3186EB102T250AM	EB	0.0942	3.8
1400	3186EC142T250AM	EC	0.0745	4.6
1700	3186ED172T250AM	ED	0.0615	5.3
2100	3186EE212T250AM	EE	0.0520	6.1
2400	3186EF242T250AM	EF	0.0460	6.8
2800	3186EG282T250AM	EG	0.0410	7.5
3100	3186EH312T250AM	EH	0.0375	8.2
1700	3186FB172T250AM	FB	0.1063	4.1
2300	3186FC232T250AM	FC	0.0866	4.9
2900	3186FD292T250AM	FD	0.0707	5.7
3500	3186FE352T250AM	FE	0.0271	9.7
4100	3186FF412T250AM	FF	0.0239	10.8
4700	3186FG472T250AM	FG	0.0215	11.8
5200	3186FH522T250AM	FH	0.0198	12.8
3400	3186GC342T250AM	GC	0.0398	8.1
4300	3186GD432T250AM	GD	0.0326	9.4
5200	3186GE522T250AM	GE	0.0280	10.7
6000	3186GF602T250AM	GF	0.0247	11.8
6900	3186GG692T250AM	GG	0.0222	13.0
7800	3186GH782T250AM	GH	0.0203	14.1
12000	3186GN123T250AM	GN	0.0150	19.5

SERIES 3186

300.0 VDC WORKING 350.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
300	3186BA301T300AM	BA	0.3800	1.4
360	3186BB361T300AM	BB	0.3176	1.6
500	3186BC501T300AM	BC	0.2337	2.1
620	3186BD621T300AM	BD	0.1896	2.4
750	3186BE751T300AM	BE	0.1580	2.8
870	3186BF871T300AM	BF	0.1371	3.2
1000	3186BG102T300AM	BG	0.1203	3.5
1000	3186BH102T300AM	BH	0.1181	3.7
540	3186DA541T300AM	DA	0.2358	2.0
650	3186DB651T300AM	DB	0.1972	2.4
890	3186DC891T300AM	DC	0.1491	3.0
1000	3186DD102T300AM	DD	0.1280	3.4
1300	3186DE132T300AM	DE	0.1036	4.0
1500	3186DF152T300AM	DF	0.0905	4.5
1700	3186DG172T300AM	DG	0.0807	5.0
2000	3186DH202T300AM	DH	0.0706	5.5
700	3186EA701T300AM	EA	0.1999	2.4
840	3186EB841T300AM	EB	0.1676	2.9
1100	3186EC112T300AM	EC	0.1310	3.4
1400	3186ED142T300AM	ED	0.1052	4.1
1700	3186EE172T300AM	EE	0.0884	4.7
2000	3186EF202T300AM	EF	0.0765	5.3
2300	3186EG232T300AM	EG	0.0546	6.5
2600	3186EH262T300AM	EH	0.0489	7.1
1400	3186FB142T300AM	FB	0.1471	3.5
1800	3186FC182T300AM	FC	0.1129	4.3
2400	3186FD242T300AM	FD	0.0584	6.3
2900	3186FE292T300AM	FE	0.0492	7.2
3300	3186FF332T300AM	FF	0.0435	8.0
3800	3186FG382T300AM	FG	0.0385	8.8
4300	3186FH432T300AM	FH	0.0347	9.7
2800	3186GC282T300AM	GC	0.0598	6.6
3500	3186GD352T300AM	GD	0.0487	7.7
4300	3186GE432T300AM	GE	0.0411	8.8
5000	3186GF502T300AM	GF	0.0360	9.8
5700	3186GG572T300AM	GG	0.0321	10.8
6400	3186GH642T300AM	GH	0.0292	11.8
10000	3186GN103T300AM	GN	0.0205	16.7

350.0 VDC WORKING 400.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
230	3186BA231T350AM	BA	0.4143	1.3
280	3186BB281T350AM	BB	0.3418	1.6
380	3186BC381T350AM	BC	0.2565	2.0
480	3186BD481T350AM	BD	0.2046	2.3
580	3186BE581T350AM	BE	0.1706	2.7
680	3186BF681T350AM	BF	0.1466	3.1
770	3186BG771T350AM	BG	0.1303	3.4
870	3186BH871T350AM	BH	0.1162	3.8
420	3186DA421T350AM	DA	0.2520	2.0
500	3186DB501T350AM	DB	0.2122	2.3
690	3186DC691T350AM	DC	0.1593	2.9
870	3186DD871T350AM	DD	0.1281	3.4
1000	3186DE102T350AM	DE	0.1112	3.9
1100	3186DF112T350AM	DF	0.0991	4.3
1300	3186DG132T350AM	DG	0.0868	4.8
1500	3186DH152T350AM	DH	0.0768	5.3
540	3186EA541T350AM	EA	0.2133	2.4
650	3186EB651T350AM	EB	0.1785	2.8
900	3186EC901T350AM	EC	0.1351	3.4
1000	3186ED102T350AM	ED	0.1152	3.9
1300	3186EE132T350AM	EE	0.0944	4.5
1500	3186EF152T350AM	EF	0.0825	5.1
1800	3186EG182T350AM	EG	0.0581	6.3
2000	3186EH202T350AM	EH	0.0528	6.9
1100	3186FB112T350AM	FB	0.1536	3.4
1400	3186FC142T350AM	FC	0.1183	4.2
1800	3186FD182T350AM	FD	0.0635	6.0
2200	3186FE222T350AM	FE	0.0531	6.9
2600	3186FF262T350AM	FF	0.0458	7.8
3000	3186FG302T350AM	FG	0.0405	8.6
3400	3186FH342T350AM	FH	0.0364	9.4
2200	3186GC222T350AM	GC	0.0626	6.5
2700	3186GD272T350AM	GD	0.0514	7.5
3300	3186GE332T350AM	GE	0.0433	8.6
3900	3186GF392T350AM	GF	0.0377	9.6
4400	3186GG442T350AM	GG	0.0338	10.5
5000	3186GH502T350AM	GH	0.0305	11.5
8100	3186GN812T350AM	GN	0.0211	16.5

400.0 VDC WORKING 450.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
200	3186BA201T400AM	BA	0.4295	1.3
240	3186BB241T400AM	BB	0.3589	1.5
330	3186BC331T400AM	BC	0.2661	1.9
410	3186BD411T400AM	BD	0.2153	2.3
500	3186BE501T400AM	BE	0.1780	2.6
580	3186BF581T400AM	BF	0.1544	3.0
660	3186BG661T400AM	BG	0.1365	3.3
750	3186BH751T400AM	BH	0.1212	3.7
360	3186DA361T400AM	DA	0.2633	1.9
430	3186DB431T400AM	DB	0.2213	2.3
590	3186DC591T400AM	DC	0.1666	2.8
740	3186DD741T400AM	DD	0.1343	3.3
890	3186DE891T400AM	DE	0.1130	3.8
1000	3186DF102T400AM	DF	0.1005	4.2
1100	3186DG112T400AM	DG	0.0914	4.7
1300	3186DH132T400AM	DH	0.0697	5.5
460	3186EA461T400AM	EA	0.2230	2.3
560	3186EB561T400AM	EB	0.1853	2.7
770	3186EC771T400AM	EC	0.1406	3.3
960	3186ED961T400AM	ED	0.1141	3.9
1100	3186EE112T400AM	EE	0.0988	4.4
1300	3186EF132T400AM	EF	0.0710	5.5
1500	3186EG152T400AM	EG	0.0622	6.1
1700	3186EH172T400AM	EH	0.0555	6.7
940	3186FB941T400AM	FB	0.1585	3.4
1200	3186FC122T400AM	FC	0.1274	4.0
1600	3186FD162T400AM	FD	0.0646	6.0
1900	3186FE192T400AM	FE	0.0550	6.8
2200	3186FF222T400AM	FF	0.0481	7.6
2500	3186FG252T400AM	FG	0.0428	8.4
2900	3186FH292T400AM	FH	0.0379	9.2
1900	3186GC192T400AM	GC	0.0648	6.4
2300	3186GD232T400AM	GD	0.0533	7.4
2800	3186GE282T400AM	GE	0.0450	8.4
3300	3186GF332T400AM	GF	0.0392	9.4
3800	3186GG382T400AM	GG	0.0348	10.4
4300	3186GH432T400AM	GH	0.0315	11.3
6900	3186GN692T400AM	GN	0.0218	16.2

450.0 VDC WORKING 525.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
180	3186BA181T450AM	BA	0.4506	1.3
220	3186BB221T450AM	BB	0.3702	1.5
300	3186BC301T450AM	BC	0.2764	1.9
380	3186BD381T450AM	BD	0.2198	2.3
450	3186BE451T450AM	BE	0.1865	2.6
530	3186BF531T450AM	BF	0.1595	2.9
610	3186BG611T450AM	BG	0.1397	3.3
680	3186BH681T450AM	BH	0.1260	3.6
330	3186DA331T450AM	DA	0.2709	1.9
390	3186DB391T450AM	DB	0.2294	2.2
540	3186DC541T450AM	DC	0.1714	2.8
680	3186DD681T450AM	DD	0.1378	3.3
820	3186DE821T450AM	DE	0.1157	3.8
950	3186DF951T450AM	DF	0.1007	4.2
1000	3186DG102T450AM	DG	0.0843	4.8
1100	3186DH112T450AM	DH	0.0763	5.3
430	3186EA431T450AM	EA	0.2262	2.3
510	3186EB511T450AM	EB	0.1909	2.7
710	3186EC711T450AM	EC	0.1437	3.3
880	3186ED881T450AM	ED	0.1169	3.9
1000	3186EE102T450AM	EE	0.0861	4.7
1200	3186EF122T450AM	EF	0.0727	5.4
1300	3186EG132T450AM	EG	0.0665	5.9
1500	3186EH152T450AM	EH	0.0590	6.5
860	3186FB861T450AM	FB	0.1618	3.4
1100	3186FC112T450AM	FC	0.0855	4.9
1400	3186FD142T450AM	FD	0.0684	5.8
1700	3186FE172T450AM	FE	0.0574	6.6
2000	3186FF202T450AM	FF	0.0496	7.5
2300	3186FG232T450AM	FG	0.0438	8.3
2600	3186FH262T450AM	FH	0.0394	9.1
1700	3186GC172T450AM	GC	0.0670	6.2
2100	3186GD212T450AM	GD	0.0547	7.3
2600	3186GE262T450AM	GE	0.0459	8.3
3000	3186GF302T450AM	GF	0.0402	9.3
3500	3186GG352T450AM	GG	0.0356	10.3
3900	3186GH392T450AM	GH	0.0323	11.2
6300	3186GN632T450AM	GN	0.0223	16.0

SERIES 3188

Long-Life Computer-Grade Aluminum Electrolytic Capacitors

DESCRIPTION:

Series 3188 Long-Life Aluminum Electrolytic Capacitors are designed for those applications where a standard computer-grade product must operate under environmental and operational stresses more severe than those normally encountered. These units are constructed of the highest-quality materials and processed to achieve the low leakage current necessary for long shelf life and long operating life with high ripple currents. The Series 3188 features a 2000 hour operating life at 105°C. It is available in 38 standard case sizes with a choice of five terminal styles. Capacitance values up to 950,000μF are available. Computer-designed for optimum performance.

FEATURES:

- 2000 hours operating life at 85°C with ripple.
- Up to 45A Ripple Current at 85°C.
- 39 Standard Case Sizes.
- Low Leakage Current.
- Computer-designed for optimum performance.
- Meets all requirements for EIA-RS-395 for type I capacitors.
- Voltage range: 6 to 400 WVDC.

6.0 VDC WORKING 9.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
46000	3188BA463U006AM	BA	0.0148	9.9
56000	3188BB563U006AM	BB	0.0128	11.6
74000	3188BC743U006AM	BC	0.0105	13.7
93000	3188BD933U006AM	BD	0.0091	15.7
100000	3188BE104U006AM	BE	0.0090	16.6
120000	3188BF124U006AM	BF	0.0083	18.3
140000	3188BG144U006AM	BG	0.0071	20.5
160000	3188BH164U006AM	BH	0.0068	22.0
83000	3188DA833U006AM	DA	0.0154	11.3
99000	3188DB993U006AM	DB	0.0134	13.1
130000	3188DC134U006AM	DC	0.0109	15.5
160000	3188DD164U006AM	DD	0.0095	17.7
190000	3188DE194U006AM	DE	0.0086	19.6
230000	3188DF234U006AM	DF	0.0079	21.4
260000	3188DG264U006AM	DG	0.0074	23.1
290000	3188DH294U006AM	DH	0.0071	24.6
100000	3188EA104U006AM	EA	0.0103	15.1
120000	3188EB124U006AM	EB	0.0090	17.4
160000	3188EC164U006AM	EC	0.0089	18.7
210000	3188ED214U006AM	ED	0.0065	23.2
250000	3188EE254U006AM	EE	0.0059	25.6
280000	3188EF284U006AM	EF	0.0063	25.9
340000	3188EG344U006AM	EG	0.0052	29.9
380000	3188EH384U006AM	EH	0.0050	30.0
210000	3188FB214U006AM	FB	0.0061	24.6
280000	3188FC284U006AM	FC	0.0051	28.4
350000	3188FD354U006DM	FD	0.0045	31.8
430000	3188FE434U006DM	FE	0.0042	34.8
500000	3188FF504U006DM	FF	0.0039	37.5
570000	3188FG574U006DM	FG	0.0038	40.0
640000	3188FH644U006DM	FH	0.0036	42.3
420000	3188GC424U006DM	GC	0.0041	35.8
530000	3188GD534U006DM	GD	0.0037	39.7
630000	3188GE634U006DM	GE	0.0034	43.1
740000	3188GF744U006DM	GF	0.0032	45.0
840000	3188GG844U006DM	GG	0.0031	45.0
950000	3188GH954U006DM	GH	0.0030	45.0

7.5 VDC WORKING 10.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
44000	3188BA443U7P5AM	BA	0.0148	9.9
52000	3188BB523U7P5AM	BB	0.0129	11.5
70000	3188BC703U7P5AM	BC	0.0105	13.7
88000	3188BD883U7P5AM	BD	0.0091	15.7
100000	3188BE104U7P5AM	BE	0.0082	17.4
110000	3188BF114U7P5AM	BF	0.0083	18.2
130000	3188BG134U7P5AM	BG	0.0077	19.8
150000	3188BH154U7P5AM	BH	0.0068	21.9
78000	3188DA783U7P5AM	DA	0.0154	11.3
93000	3188DB933U7P5AM	DB	0.0134	13.1
120000	3188DC124U7P5AM	DC	0.0110	15.5
150000	3188DD154U7P5AM	DD	0.0095	17.7
180000	3188DE184U7P5AM	DE	0.0086	19.6
210000	3188DF214U7P5AM	DF	0.0079	21.4
250000	3188DG254U7P5AM	DG	0.0074	23.1
280000	3188DH284U7P5AM	DH	0.0071	24.6
100000	3188EA104U7P5AM	EA	0.0103	15.1
110000	3188EB114U7P5AM	EB	0.0110	15.7
150000	3188EC154U7P5AM	EC	0.0089	18.7
190000	3188ED194U7P5AM	ED	0.0077	21.3
230000	3188EE234U7P5AM	EE	0.0069	23.7
280000	3188EF284U7P5AM	EF	0.0055	27.8
320000	3188EG324U7P5AM	EG	0.0052	29.9
360000	3188EH364U7P5AM	EH	0.0050	30.0
200000	3188FB204U7P5AM	FB	0.0076	21.9
270000	3188FC274U7P5AM	FC	0.0051	28.4
330000	3188FD334U7P5AM	FD	0.0056	28.7
400000	3188FE404U7P5DM	FE	0.0051	31.6
450000	3188FF454U7P5DM	FF	0.0044	35.3
540000	3188FG544U7P5DM	FG	0.0038	40.0
600000	3188FH604U7P5DM	FH	0.0043	38.7
390000	3188GC394U7P5DM	GC	0.0047	33.4
490000	3188GD494U7P5DM	GD	0.0042	37.2
590000	3188GE594U7P5DM	GE	0.0039	40.6
690000	3188GF694U7P5DM	GF	0.0036	43.6
790000	3188GG794U7P5DM	GG	0.0035	45.0
890000	3188GH894U7P5DM	GH	0.0034	45.0

SERIES 3188

10.0 VDC WORKING 15.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
34000	3188BA343U010AM	BA	0.0307	6.9
41000	3188BB413U010AM	BB	0.0264	8.1
55000	3188BC553U010AM	BC	0.0211	9.7
69000	3188BD693U010AM	BD	0.0180	11.1
83000	3188BE833U010AM	BE	0.0160	12.5
96000	3188BF963U010AM	BF	0.0146	13.7
110000	3188BG114U010AM	BG	0.0136	14.9
120000	3188BH124U010AM	BH	0.0128	16.0
61000	3188DA613U010AM	DA	0.0157	11.2
73000	3188DB733U010AM	DB	0.0136	13.0
98000	3188DC983U010AM	DC	0.0111	15.4
120000	3188DD124U010AM	DD	0.0096	17.6
140000	3188DE144U010AM	DE	0.0087	19.5
170000	3188DF174U010AM	DF	0.0080	21.3
190000	3188DG194U010AM	DG	0.0075	23.0
210000	3188DH214U010AM	DH	0.0083	22.7
79000	3188EA793U010AM	EA	0.0104	15.0
95000	3188EB953U010AM	EB	0.0091	17.3
120000	3188EC124U010AM	EC	0.0075	20.3
150000	3188ED154U010AM	ED	0.0066	23.0
180000	3188EE184U010AM	EE	0.0070	23.6
220000	3188EF224U010AM	EF	0.0055	27.7
250000	3188EG254U010AM	EG	0.0052	29.7
280000	3188EH284U010AM	EH	0.0050	30.0
150000	3188FB154U010AM	FB	0.0077	21.8
210000	3188FC214U010AM	FC	0.0064	25.4
260000	3188FD264U010AM	FD	0.0056	28.6
310000	3188FE314U010DM	FE	0.0051	31.4
360000	3188FF364U010DM	FF	0.0045	35.2
420000	3188FG424U010DM	FG	0.0045	36.4
470000	3188FH474U010DM	FH	0.0044	38.6
300000	3188GC304U010DM	GC	0.0048	33.0
390000	3188GD394U010DM	GD	0.0042	37.1
470000	3188GE474U010DM	GE	0.0039	40.4
540000	3188GF544U010DM	GF	0.0037	43.5
620000	3188GG624U010DM	GG	0.0035	45.0
700000	3188GH704U010DM	GH	0.0034	45.0

15.0 VDC WORKING 20.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
25000	3188BA253U015AM	BA	0.0312	6.8
30000	3188BB303U015AM	BB	0.0268	8.0
41000	3188BC413U015AM	BC	0.0273	8.5
51000	3188BD513U015AM	BD	0.0182	11.1
61000	3188BE613U015AM	BE	0.0162	12.4
72000	3188BF723U015AM	BF	0.0147	13.7
82000	3188BG823U015AM	BG	0.0137	14.8
92000	3188BH923U015AM	BH	0.0130	15.9
45000	3188DA453U015AM	DA	0.0159	11.2
55000	3188DB553U015AM	DB	0.0138	12.9
73000	3188DC733U015AM	DC	0.0112	15.3
91000	3188DD913U015AM	DD	0.0097	17.5
110000	3188DE114U015AM	DE	0.0105	17.7
120000	3188DF124U015AM	DF	0.0081	21.2
140000	3188DG144U015AM	DG	0.0089	21.1
160000	3188DH164U015AM	DH	0.0084	22.6
59000	3188EA593U015AM	EA	0.0174	11.6
71000	3188EB713U015AM	EB	0.0150	13.5
95000	3188EC953U015AM	EC	0.0121	16.0
110000	3188ED114U015AM	ED	0.0105	18.2
140000	3188EE144U015AM	EE	0.0094	20.3
160000	3188EF164U015AM	EF	0.0086	22.2
190000	3188EG194U015AM	EG	0.0080	24.0
210000	3188EH214U015AM	EH	0.0076	25.6
110000	3188FB114U015AM	FB	0.0111	18.2
150000	3188FC154U015AM	FC	0.0065	25.2
190000	3188FD194U015AM	FD	0.0057	28.4
230000	3188FE234U015DM	FE	0.0052	31.3
270000	3188FF274U015DM	FF	0.0048	33.9
310000	3188FG314U015DM	FG	0.0046	36.2
350000	3188FH354U015DM	FH	0.0044	38.4
230000	3188GC234U015DM	GC	0.0057	30.2
290000	3188GD294U015DM	GD	0.0051	33.8
350000	3188GE354U015DM	GE	0.0046	37.1
400000	3188GF404U015DM	GF	0.0043	40.0
460000	3188GG464U015DM	GG	0.0041	42.7
520000	3188GH524U015DM	GH	0.0039	45.0
650000	3188GN654U015DM	GN	0.0039	45.0

20.0 VDC WORKING 30.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
20000	3188BA203U020AM	BA	0.0412	5.9
24000	3188BB243U020AM	BB	0.0352	7.0
32000	3188BC323U020AM	BC	0.0217	9.5
40000	3188BD403U020AM	BD	0.0185	11.0
48000	3188BE483U020AM	BE	0.0164	12.3
56000	3188BF563U020AM	BF	0.0149	13.6
64000	3188BG643U020AM	BG	0.0139	14.7
72000	3188BH723U020AM	BH	0.0131	15.8
35000	3188DA353U020AM	DA	0.0161	11.1
42000	3188DB423U020AM	DB	0.0140	12.8
57000	3188DC573U020AM	DC	0.0114	15.2
71000	3188DD713U020AM	DD	0.0098	17.4
85000	3188DE853U020AM	DE	0.0088	19.3
100000	3188DF104U020AM	DF	0.0096	19.4
110000	3188DG114U020AM	DG	0.0090	21.0
120000	3188DH124U020AM	DH	0.0073	24.2
46000	3188EA463U020AM	EA	0.0176	11.6
55000	3188EB553U020AM	EB	0.0152	13.4
74000	3188EC743U020AM	EC	0.0123	15.9
92000	3188ED923U020AM	ED	0.0106	18.2
110000	3188EE114U020AM	EE	0.0095	20.2
120000	3188EF124U020AM	EF	0.0087	22.1
140000	3188EG144U020AM	EG	0.0081	23.8
160000	3188EH164U020AM	EH	0.0077	25.5
92000	3188FB923U020AM	FB	0.0112	18.1
120000	3188FC124U020AM	FC	0.0091	21.3
150000	3188FD154U020AM	FD	0.0079	24.1
180000	3188FE184U020AM	FE	0.0071	26.7
210000	3188FF214U020AM	FF	0.0065	29.1
240000	3188FG244U020DM	FG	0.0061	31.3
270000	3188FH274U020DM	FH	0.0058	33.4
180000	3188GC184U020AM	GC	0.0071	27.1
220000	3188GD224U020AM	GD	0.0066	29.7
270000	3188GE274U020DM	GE	0.0047	36.9
310000	3188GF314U020DM	GF	0.0044	39.9
360000	3188GG364U020DM	GG	0.0041	42.6
410000	3188GH414U020DM	GH	0.0040	45.0
650000	3188GN654U020DM	GN	0.0039	45.0

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25.0 VDC WORKING 40.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
17000	3188BA173U025AM	BA	0.0416	5.9
20000	3188BB203U025AM	BB	0.0355	7.0
27000	3188BC273U025AM	BC	0.0279	8.4
34000	3188BD343U025AM	BD	0.0234	9.8
40000	3188BE403U025AM	BE	0.0205	11.0
47000	3188BF473U025AM	BF	0.0185	12.2
54000	3188BG543U025AM	BG	0.0170	13.3
61000	3188BH613U025AM	BH	0.0159	14.4
30000	3188DA303U025AM	DA	0.0206	9.8
36000	3188DB363U025AM	DB	0.0177	11.4
48000	3188DC483U025AM	DC	0.0141	13.7
60000	3188DD603U025AM	DD	0.0121	15.7
72000	3188DE723U025AM	DE	0.0107	17.6
84000	3188DF843U025AM	DF	0.0097	19.3
96000	3188DG963U025AM	DG	0.0090	20.9
100000	3188DH104U025AM	DH	0.0085	22.4
39000	3188EA393U025AM	EA	0.0233	10.1
47000	3188EB473U025AM	EB	0.0199	11.7
62000	3188EC623U025AM	EC	0.0158	14.0
78000	3188ED783U025AM	ED	0.0134	16.1
94000	3188EE943U025AM	EE	0.0118	18.1
100000	3188EF104U025AM	EF	0.0107	19.9
120000	3188EG124U025AM	EG	0.0099	21.6
140000	3188EH144U025AM	EH	0.0093	23.2
78000	3188FB783U025AM	FB	0.0099	19.2
100000	3188FC104U025AM	FC	0.0080	22.7
130000	3188FD134U025AM	FD	0.0069	25.8
150000	3188FE154U025AM	FE	0.0062	28.5
180000	3188FF184U025DM	FF	0.0057	31.1
200000	3188FG204U025DM	FG	0.0054	33.5
230000	3188FH234U025DM	FH	0.0051	35.7
150000	3188GC154U025AM	GC	0.0072	27.0
190000	3188GD194U025DM	GD	0.0062	30.5
230000	3188GE234U025DM	GE	0.0056	33.7
260000	3188GF264U025DM	GF	0.0052	36.6
300000	3188GG304U025DM	GG	0.0048	39.4
340000	3188GH344U025DM	GH	0.0046	41.9
550000	3188GN554U025DM	GN	0.0039	45.0

30.0 VDC WORKING 45.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
14000	3188BA143U030AM	BA	0.0421	5.9
17000	3188BB173U030AM	BB	0.0359	6.9
23000	3188BC233U030AM	BC	0.0282	8.4
29000	3188BD293U030AM	BD	0.0237	9.7
35000	3188BE353U030AM	BE	0.0207	11.0
41000	3188BF413U030AM	BF	0.0186	12.2
47000	3188BG473U030AM	BG	0.0171	13.3
53000	3188BH533U030AM	BH	0.0160	14.3
26000	3188DA263U030AM	DA	0.0207	9.8
31000	3188DB313U030AM	DB	0.0179	11.4
42000	3188DC423U030AM	DC	0.0143	13.6
52000	3188DD523U030AM	DD	0.0121	15.6
63000	3188DE633U030AM	DE	0.0108	17.5
73000	3188DF733U030AM	DF	0.0098	19.3
84000	3188DG843U030AM	DG	0.0091	20.9
94000	3188DH943U030AM	DH	0.0086	22.4
34000	3188EA343U030AM	EA	0.0234	10.0
41000	3188EB413U030AM	EB	0.0201	11.7
54000	3188EC543U030AM	EC	0.0160	14.0
58000	3188ED683U030AM	ED	0.0135	16.1
82000	3188EE823U030AM	EE	0.0119	18.0
95000	3188EF953U030AM	EF	0.0108	19.9
100000	3188EG104U030AM	EG	0.0100	21.5
120000	3188EH124U030AM	EH	0.0093	23.2
68000	3188FB683U030AM	FB	0.0147	15.7
91000	3188FC913U030AM	FC	0.0118	18.7
110000	3188FD114U030AM	FD	0.0100	21.4
130000	3188FE134U030AM	FE	0.0089	23.9
150000	3188FF154U030AM	FF	0.0081	26.2
180000	3188FG184U030AM	FG	0.0075	28.4
200000	3188FH204U030DM	FH	0.0070	30.4
130000	3188GC134U030AM	GC	0.0072	26.9
160000	3188GD164U030DM	GD	0.0063	30.4
200000	3188GE204U030DM	GE	0.0056	33.6
230000	3188GF234U030DM	GF	0.0052	36.6
260000	3188GG264U030DM	GG	0.0049	39.3
300000	3188GH304U030DM	GH	0.0046	41.8
480000	3188GN484U030DM	GN	0.0039	45.0

40.0 VDC WORKING 55.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
7700	3188BA772U040AM	BA	0.0455	5.7
9300	3188BB932U040AM	BB	0.0387	6.7
12000	3188BC123U040AM	BC	0.0305	8.1
15000	3188BD153U040AM	BD	0.0255	9.4
18000	3188BE183U040AM	BE	0.0222	10.6
21000	3188BF213U040AM	BF	0.0199	11.8
24000	3188BG243U040AM	BG	0.0182	12.8
28000	3188BH283U040AM	BH	0.0169	13.9
13000	3188DA133U040AM	DA	0.0659	5.5
16000	3188DB163U040AM	DB	0.0557	6.4
22000	3188DC223U040AM	DC	0.0153	13.1
27000	3188DD273U040AM	DD	0.0130	15.1
33000	3188DE333U040AM	DE	0.0115	17.0
38000	3188DF383U040AM	DF	0.0104	18.7
44000	3188DG443U040AM	DG	0.0096	20.3
49000	3188DH493U040AM	DH	0.0090	21.8
17000	3188EA173U040AM	EA	0.0254	9.6
21000	3188EB213U040AM	EB	0.0217	11.2
28000	3188EC283U040AM	EC	0.0172	13.5
35000	3188ED353U040AM	ED	0.0145	15.5
42000	3188EE423U040AM	EE	0.0127	17.4
50000	3188EF503U040AM	EF	0.0114	19.3
57000	3188EG573U040AM	EG	0.0105	20.9
64000	3188EH643U040AM	EH	0.0098	22.5
35000	3188FB353U040AM	FB	0.0159	15.2
47000	3188FC473U040AM	FC	0.0126	18.1
59000	3188FD593U040AM	FD	0.0107	20.7
71000	3188FE713U040AM	FE	0.0094	23.2
83000	3188FF833U040AM	FF	0.0085	25.5
95000	3188FG953U040AM	FG	0.0079	27.6
100000	3188FH104U040AM	FH	0.0074	29.6
70000	3188GC703U040AM	GC	0.0104	22.4
87000	3188GD873U040AM	GD	0.0089	25.6
100000	3188GE104U040AM	GE	0.0078	28.5
120000	3188GF124U040DM	GF	0.0071	31.2
140000	3188GG144U040DM	GG	0.0066	33.7
150000	3188GH154U040DM	GH	0.0062	36.1
250000	3188GN254U040DM	GN	0.0051	45.0

50.0 VDC WORKING 75.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
6000	3188BA602U050AM	BA	0.0466	5.6
7200	3188BB722U050AM	BB	0.0397	6.6
9600	3188BC962U050AM	BC	0.0310	8.0
12000	3188BD123U050AM	BD	0.0260	9.3
14000	3188BE143U050AM	BE	0.0227	10.5
16000	3188BF163U050AM	BF	0.0204	11.6
19000	3188BG193U050AM	BG	0.0186	12.7
21000	3188BH213U050AM	BH	0.0173	13.8
10000	3188DA103U050AM	DA	0.0669	5.4
12000	3188DB123U050AM	DB	0.0566	6.4
17000	3188DC173U050AM	DC	0.0437	7.8
21000	3188DD213U050AM	DD	0.0362	9.1
25000	3188DE253U050AM	DE	0.0313	10.3
29000	3188DF293U050AM	DF	0.0278	11.4
34000	3188DG343U050AM	DG	0.0251	12.6
38000	3188DH383U050AM	DH	0.0232	13.6
13000	3188EA133U050AM	EA	0.0260	9.5
16000	3188EB163U050AM	EB	0.0222	11.1
22000	3188EC223U050AM	EC	0.0175	13.3
27000	3188ED273U050AM	ED	0.0147	15.4
33000	3188EE333U050AM	EE	0.0129	17.3
38000	3188EF383U050AM	EF	0.0116	19.1
44000	3188EG443U050AM	EG	0.0107	20.8
49000	3188EH493U050AM	EH	0.0100	22.4
27000	3188FB273U050AM	FB	0.0306	10.9
36000	3188FC363U050AM	FC	0.0239	13.1
45000	3188FD453U050AM	FD	0.0199	15.2
55000	3188FE553U050AM	FE	0.0172	17.2
64000	3188FF643U050AM	FF	0.0153	19.0
73000	3188FG733U050AM	FG	0.0140	20.7
82000	3188FH823U050AM	FH	0.0129	22.4
54000	3188GC543U050AM	GC	0.0162	17.9
67000	3188GD673U050AM	GD	0.0136	20.6
81000	3188GE813U050AM	GE	0.0119	23.1
94000	3188GF943U050AM	GF	0.0107	25.5
100000	3188GG104U050AM	GG	0.0098	27.7
120000	3188GH124U050AM	GH	0.0091	29.8
190000	3188GN194U050DM	GN	0.0071	40.2

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60.0 VDC WORKING 90.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
4400	3188BA442U060AM	BA	0.0484	5.5
5300	3188BB532U060AM	BB	0.0411	6.5
7100	3188BC712U060AM	BC	0.0321	7.8
8900	3188BD892U060AM	BD	0.0268	9.1
10000	3188BE103U060AM	BE	0.0235	10.3
12000	3188BF123U060AM	BF	0.0210	11.5
14000	3188BG143U060AM	BG	0.0191	12.6
16000	3188BH163U060AM	BH	0.0177	13.6
7900	3188DA792U060AM	DA	0.0678	5.4
9500	3188DB952U060AM	DB	0.0574	6.3
12000	3188DC123U060AM	DC	0.0446	7.7
15000	3188DD153U060AM	DD	0.0369	9.0
19000	3188DE193U060AM	DE	0.0317	10.2
22000	3188DF223U060AM	DF	0.0281	11.4
25000	3188DG253U060AM	DG	0.0255	12.5
28000	3188DH283U060AM	DH	0.0235	13.5
10000	3188EA103U060AM	EA	0.0823	5.3
12000	3188EB123U060AM	EB	0.0695	6.3
16000	3188EC163U060AM	EC	0.0536	7.6
20000	3188ED203U060AM	ED	0.0441	8.9
24000	3188EE243U060AM	EE	0.0378	10.1
28000	3188EF283U060AM	EF	0.0333	11.3
32000	3188EG323U060AM	EG	0.0300	12.4
37000	3188EH373U060AM	EH	0.0275	13.5
16000	3188FB163U060AM	FB	0.0276	11.5
22000	3188FC223U060AM	FC	0.0215	13.8
27000	3188FD273U060AM	FD	0.0180	16.0
33000	3188FE333U060AM	FE	0.0157	18.0
38000	3188FF383U060AM	FF	0.0140	19.9
44000	3188FG443U060AM	FG	0.0128	21.7
49000	3188FH493U060AM	FH	0.0119	23.4
32000	3188GC323U060AM	GC	0.0278	13.7
40000	3188GD403U060AM	GD	0.0231	15.9
48000	3188GE483U060AM	GE	0.0199	17.9
57000	3188GF573U060AM	GF	0.0177	19.8
65000	3188GG653U060AM	GG	0.0160	21.6
73000	3188GH733U060AM	GH	0.0147	23.4
110000	3188GN114U060DM	GN	0.0111	32.1

75.0 VDC WORKING 100.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
3300	3188BA332U075AM	BA	0.0506	5.4
4000	3188BB402U075AM	BB	0.0429	6.3
5300	3188BC532U075AM	BC	0.0335	7.7
6600	3188BD662U075AM	BD	0.0279	8.9
8000	3188BE802U075AM	BE	0.0242	10.1
9300	3188BF932U075AM	BF	0.0217	11.3
10000	3188BG103U075AM	BG	0.0200	12.3
12000	3188BH123U075AM	BH	0.0183	13.4
5900	3188DA592U075AM	DA	0.0691	5.4
7100	3188DB712U075AM	DB	0.0585	6.3
9400	3188DC942U075AM	DC	0.0453	7.6
11000	3188DD113U075AM	DD	0.0377	8.9
14000	3188DE143U075AM	DE	0.0323	10.1
16000	3188DF163U075AM	DF	0.0287	11.2
18000	3188DG183U075AM	DG	0.0260	12.3
21000	3188DH213U075AM	DH	0.0239	13.4
7600	3188EA762U075AM	EA	0.0836	5.3
9200	3188EB922U075AM	EB	0.0706	6.2
12000	3188EC123U075AM	EC	0.0544	7.6
15000	3188ED153U075AM	ED	0.0447	8.8
18000	3188EE183U075AM	EE	0.0383	10.0
21000	3188EF213U075AM	EF	0.0338	11.2
24000	3188EG243U075AM	EG	0.0305	12.3
27000	3188EH273U075AM	EH	0.0279	13.4
12000	3188FB123U075AM	FB	0.0282	11.4
16000	3188FC163U075AM	FC	0.0221	13.7
20000	3188FD203U075AM	FD	0.0184	15.8
24000	3188FE243U075AM	FE	0.0160	17.8
28000	3188FF283U075AM	FF	0.0143	19.7
32000	3188FG323U075AM	FG	0.0131	21.4
37000	3188FH373U075AM	FH	0.0121	23.2
24000	3188GC243U075AM	GC	0.0282	13.6
30000	3188GD303U075AM	GD	0.0234	15.7
36000	3188GE363U075AM	GE	0.0202	17.8
42000	3188GF423U075AM	GF	0.0179	19.7
48000	3188GG483U075AM	GG	0.0162	21.5
54000	3188GH543U075AM	GH	0.0149	23.2
88000	3188GN883U075DM	GN	0.0112	31.9

100.0 VDC WORKING 150.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
1400	3188BA142T100AM	BA	0.1068	3.7
1700	3188BB172T100AM	BB	0.0894	4.4
2200	3188BC222T100AM	BC	0.0697	5.3
2800	3188BD282T100AM	BD	0.0565	6.3
3400	3188BE342T100AM	BE	0.0479	7.2
3900	3188BF392T100AM	BF	0.0424	8.1
4500	3188BG452T100AM	BG	0.0379	8.9
5100	3188BH512T100AM	BH	0.0345	9.7
2500	3188DA252T100AM	DA	0.0971	4.5
3000	3188DB302T100AM	DB	0.0820	5.3
4000	3188DC402T100AM	DC	0.0631	6.5
5000	3188DD502T100AM	DD	0.0519	7.6
6000	3188DE602T100AM	DE	0.0445	8.6
7000	3188DF702T100AM	DF	0.0392	9.6
8000	3188DG802T100AM	DG	0.0353	10.6
9000	3188DH902T100AM	DH	0.0323	11.5
3200	3188EA322T100AM	EA	0.1038	4.8
3900	3188EB392T100AM	EB	0.0873	5.6
5200	3188EC522T100AM	EC	0.0671	6.8
6500	3188ED652T100AM	ED	0.0551	8.0
7800	3188EE782T100AM	EE	0.0471	9.1
9100	3188EF912T100AM	EF	0.0415	10.1
10000	3188EG103T100AM	EG	0.0376	11.1
11000	3188EH113T100AM	EH	0.0344	12.0
6500	3188FB652T100AM	FB	0.1146	5.6
8700	3188FC872T100AM	FC	0.0877	6.9
10000	3188FD103T100AM	FD	0.0722	8.0
13000	3188FE133T100AM	FE	0.0610	9.1
15000	3188FF153T100AM	FF	0.0535	10.2
17000	3188FG173T100AM	FG	0.0479	11.2
19000	3188FH193T100AM	FH	0.0436	12.2
12000	3188GC123T100AM	GC	0.0381	11.7
16000	3188GD163T100AM	GD	0.0311	13.6
19000	3188GE193T100AM	GE	0.0268	15.4
22000	3188GF223T100AM	GF	0.0237	17.1
25000	3188GG253T100AM	GG	0.0214	18.7
29000	3188GH293T100AM	GH	0.0195	20.3
46000	3188GN463T100AM	GN	0.0144	28.2

125.0 VDC WORKING 150.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
820	3188BA821T125AM	BA	0.1538	3.1
990	3188BB991T125AM	BB	0.1286	3.7
1300	3188BC132T125AM	BC	0.0990	4.5
1600	3188BD162T125AM	BD	0.0814	5.2
1900	3188BE192T125AM	BE	0.0695	6.0
2300	3188BF232T125AM	BF	0.0591	6.8
2500	3188BG262T125AM	BG	0.0530	7.5
2900	3188BH292T125AM	BH	0.0483	8.2
1400	3188DA142T125AM	DA	0.1150	4.1
1700	3188DB172T125AM	DB	0.0964	4.9
2300	3188DC232T125AM	DC	0.0736	6.0
2900	3188DD292T125AM	DD	0.0601	7.0
3500	3188DE352T125AM	DE	0.0512	8.0
4100	3188DF412T125AM	DF	0.0449	9.0
4700	3188DG472T125AM	DG	0.0403	9.9
5300	3188DH532T125AM	DH	0.0367	10.8
1900	3188EA192T125AM	EA	0.1113	4.6
2300	3188EB232T125AM	EB	0.0936	5.4
3000	3188EC302T125AM	EC	0.0723	6.6
3800	3188ED382T125AM	ED	0.0590	7.7
4600	3188EE462T125AM	EE	0.0503	8.8
5300	3188EF532T125AM	EF	0.0443	9.8
6100	3188EG612T125AM	EG	0.0397	10.8
6900	3188EH692T125AM	EH	0.0362	11.7
3800	3188FB382T125AM	FB	0.1093	5.8
5100	3188FC512T125AM	FC	0.0836	7.0
6400	3188FD642T125AM	FD	0.0683	8.2
7700	3188FE772T125AM	FE	0.0582	9.3
9000	3188FF902T125AM	FF	0.0510	10.4
10000	3188FG103T125AM	FG	0.0459	11.4
11000	3188FH113T125AM	FH	0.0419	12.4
7600	3188GC762T125AM	GC	0.0383	11.7
9500	3188GD952T125AM	GD	0.0315	13.6
11000	3188GE113T125AM	GE	0.0273	15.3
13000	3188GF133T125AM	GF	0.0240	17.0
15000	3188GG153T125AM	GG	0.0216	18.6
17000	3188GH173T125AM	GH	0.0198	20.2
27000	3188GN273T125AM	GN	0.0146	28.0

SERIES 3188

150.0 VDC WORKING 200.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
540	3188BA541T150AM	BA	0.1551	3.1
640	3188BB641T150AM	BB	0.1314	3.6
860	3188BC861T150AM	BC	0.0995	4.5
1000	3188BD102T150AM	BD	0.0854	5.1
1200	3188BE122T150AM	BE	0.0723	5.9
1500	3188BF152T150AM	BF	0.0599	6.8
1700	3188BG172T150AM	BG	0.0537	7.5
1900	3188BH192T150AM	BH	0.0488	8.2
970	3188DA971T150AM	DA	0.1115	4.2
1100	3188DB112T150AM	DB	0.0961	4.9
1500	3188DC152T150AM	DC	0.0731	6.0
1900	3188DD192T150AM	DD	0.0595	7.1
2300	3188DE232T150AM	DE	0.0507	8.1
2700	3188DF272T150AM	DF	0.0444	9.0
3100	3188DG312T150AM	DG	0.0398	10.0
3400	3188DH342T150AM	DH	0.0367	10.8
1200	3188EA122T150AM	EA	0.1104	4.6
1500	3188EB152T150AM	EB	0.0919	5.5
2000	3188EC202T150AM	EC	0.0706	6.6
2500	3188ED252T150AM	ED	0.0578	7.8
3000	3188EE302T150AM	EE	0.0494	8.8
3500	3188EF352T150AM	EF	0.0435	9.9
4000	3188EG402T150AM	EG	0.0390	10.9
4500	3188EH452T150AM	EH	0.0356	11.8
2500	3188FB252T150AM	FB	0.1053	5.9
3300	3188FC332T150AM	FC	0.0808	7.1
4200	3188FD422T150AM	FD	0.0659	8.3
5000	3188FE502T150AM	FE	0.0563	9.5
5900	3188FF592T150AM	FF	0.0493	10.6
6700	3188FG672T150AM	FG	0.0443	11.7
7600	3188FH762T150AM	FH	0.0403	12.7
4900	3188GC492T150AM	GC	0.0374	11.8
6200	3188GD622T150AM	GD	0.0308	13.7
7400	3188GE742T150AM	GE	0.0265	15.5
8700	3188GF872T150AM	GF	0.0234	17.2
9900	3188GG992T150AM	GG	0.0211	18.8
11000	3188GH113T150AM	GH	0.0194	20.4
18000	3188GN183T150AM	GN	0.0143	28.3

200.0 VDC WORKING 250.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
360	3188BA361T200AM	BA	0.1614	3.0
440	3188BB441T200AM	BB	0.1336	3.6
600	3188BC601T200AM	BC	0.1021	4.4
750	3188BD751T200AM	BD	0.0830	5.2
900	3188BE901T200AM	BE	0.0703	6.0
1000	3188BF102T200AM	BF	0.0634	6.6
1200	3188BG122T200AM	BG	0.0545	7.4
1300	3188BH132T200AM	BH	0.0506	8.0
650	3188DA651T200AM	DA	0.1148	4.2
790	3188DB791T200AM	DB	0.0962	4.9
1000	3188DC102T200AM	DC	0.0781	5.8
1300	3188DD132T200AM	DD	0.0629	6.9
1600	3188DE162T200AM	DE	0.0531	7.9
1800	3188DF182T200AM	DF	0.0472	8.8
2100	3188DG212T200AM	DG	0.0420	9.7
2400	3188DH242T200AM	DH	0.0381	10.6
850	3188EA851T200AM	EA	0.1110	4.6
1000	3188EB102T200AM	EB	0.0942	5.4
1400	3188EC142T200AM	EC	0.0745	6.5
1700	3188ED172T200AM	ED	0.0615	7.5
2100	3188EE212T200AM	EE	0.0520	8.6
2400	3188EF242T200AM	EF	0.0460	9.6
2800	3188EG282T200AM	EG	0.0410	10.6
3100	3188EH312T200AM	EH	0.0375	11.5
1700	3188FB172T200AM	FB	0.1063	5.9
2300	3188FC232T200AM	FC	0.0866	6.9
2900	3188FD292T200AM	FD	0.0707	8.1
3500	3188FE352T200AM	FE	0.0601	9.2
4100	3188FF412T200AM	FF	0.0526	10.3
4700	3188FG472T200AM	FG	0.0471	11.3
5200	3188FH522T200AM	FH	0.0198	18.1
3400	3188GC342T200AM	GC	0.0398	11.5
4300	3188GD432T200AM	GD	0.0326	13.3
5200	3188GE522T200AM	GE	0.0280	15.1
6000	3188GF602T200AM	GF	0.0247	16.7
6900	3188GG692T200AM	GG	0.0222	18.4
7800	3188GH782T200AM	GH	0.0203	19.9
12000	3188GN123T200AM	GN	0.0150	27.6

250.0 VDC WORKING 300.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
280	3188BA281T250AM	BA	0.1782	2.9
340	3188BB341T250AM	BB	0.1481	3.4
470	3188BC471T250AM	BC	0.1117	4.2
590	3188BD591T250AM	BD	0.0903	5.0
710	3188BE711T250AM	BE	0.0763	5.7
820	3188BF821T250AM	BF	0.0669	6.4
940	3188BG941T250AM	BG	0.0593	7.1
1000	3188BH102T250AM	BH	0.0558	7.7
510	3188DA511T250AM	DA	0.1240	4.0
610	3188DB611T250AM	DB	0.1046	4.7
840	3188DC841T250AM	DC	0.0816	5.7
1000	3188DD102T250AM	DD	0.0682	6.6
1200	3188DE122T250AM	DE	0.0580	7.5
1400	3188DF142T250AM	DF	0.0508	8.4
1600	3188DG162T250AM	DG	0.0455	9.3
1900	3188DH192T250AM	DH	0.0405	10.3
660	3188EA661T250AM	EA	0.1186	4.5
800	3188EB801T250AM	EB	0.0995	5.2
1000	3188EC102T250AM	EC	0.0782	6.3
1300	3188ED132T250AM	ED	0.0657	7.3
1600	3188EE162T250AM	EE	0.0555	8.3
1900	3188EF192T250AM	EF	0.0483	9.4
2200	3188EG222T250AM	EG	0.0431	10.3
2400	3188EH242T250AM	EH	0.0397	11.2
1300	3188FB132T250AM	FB	0.1105	5.7
1800	3188FC182T250AM	FC	0.0893	6.8
2300	3188FD232T250AM	FD	0.0726	8.0
2700	3188FE272T250AM	FE	0.0620	9.0
3200	3188FF322T250AM	FF	0.0254	14.8
3600	3188FG362T250AM	FG	0.0230	16.2
4100	3188FH412T250AM	FH	0.0209	17.6
2700	3188GC272T250AM	GC	0.0414	11.2
3400	3188GD342T250AM	GD	0.0340	13.1
4000	3188GE402T250AM	GE	0.0293	14.7
4700	3188GF472T250AM	GF	0.0257	16.4
5400	3188GG542T250AM	GG	0.0231	18.0
6100	3188GH612T250AM	GH	0.0211	19.5
9800	3188GN982T250AM	GN	0.0154	27.3

300.0 VDC WORKING 350.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
230	3188BA231T300AM	BA	0.4143	1.9
280	3188BB281T300AM	BB	0.3418	2.2
380	3188BC381T300AM	BC	0.2565	2.8
480	3188BD481T300AM	BD	0.2046	3.3
580	3188BE581T300AM	BE	0.1706	3.8
680	3188BF681T300AM	BF	0.1466	4.3
770	3188BG771T300AM	BG	0.1303	4.8
870	3188BH871T300AM	BH	0.1162	5.3
420	3188DA421T300AM	DA	0.2520	2.8
500	3188DB501T300AM	DB	0.2122	3.3
690	3188DC691T300AM	DC	0.1593	4.1
870	3188DD871T300AM	DD	0.1281	4.8
1000	3188DE102T300AM	DE	0.1112	5.4
1100	3188DF112T300AM	DF	0.0991	6.1
1300	3188DG132T300AM	DG	0.0868	6.8
1500	3188DH152T300AM	DH	0.0768	7.5
540	3188EA541T300AM	EA	0.2133	3.3
650	3188EB651T300AM	EB	0.1785	3.9
900	3188EC901T300AM	EC	0.1351	4.8
1000	3188ED102T300AM	ED	0.1152	5.5
1300	3188EE132T300AM	EE	0.0944	6.4
1500	3188EF152T300AM	EF	0.0825	7.2
1800	3188EG182T300AM	EG	0.0713	8.0
2000	3188EH202T300AM	EH	0.0647	8.8
1100	3188FB112T300AM	FB	0.1536	4.9
1400	3188FC142T300AM	FC	0.1183	5.9
1800	3188FD182T300AM	FD	0.0997	6.8
2200	3188FE222T300AM	FE	0.0840	7.8
2600	3188FF262T300AM	FF	0.0458	11.0
3000	3188FG302T300AM	FG	0.0405	12.2
3400	3188FH342T300AM	FH	0.0364	13.3
2200	3188GC222T300AM	GC	0.0626	9.1
2700	3188GD272T300AM	GD	0.0514	10.6
3300	3188GE332T300AM	GE	0.0433	12.1
3900	3188GF392T300AM	GF	0.0377	13.6
4400	3188GG442T300AM	GG	0.0338	14.9
5000	3188GH502T300AM	GH	0.0305	16.3
8100	3188GN812T300AM	GN	0.0211	23.3

SERIES 3188

350.0 VDC WORKING 400.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
200	3188BA201T350AM	BA	0.4295	1.8
240	3188BB241T350AM	BB	0.3589	2.2
330	3188BC331T350AM	BC	0.2661	2.7
410	3188BD411T350AM	BD	0.2153	3.2
500	3188BE501T350AM	BE	0.1780	3.7
580	3188BF581T350AM	BF	0.1544	4.2
660	3188BG661T350AM	BG	0.1365	4.7
750	3188BH751T350AM	BH	0.1212	5.2
360	3188DA361T350AM	DA	0.2633	2.7
430	3188DB431T350AM	DB	0.2213	3.2
590	3188DC591T350AM	DC	0.1666	4.0
740	3188DD741T350AM	DD	0.1343	4.7
890	3188DE891T350AM	DE	0.1130	5.4
1000	3188DF102T350AM	DF	0.1005	6.0
1100	3188DG112T350AM	DG	0.0914	6.6
1300	3188DH132T350AM	DH	0.0794	7.3
460	3188EA461T350AM	EA	0.2230	3.3
560	3188EB561T350AM	EB	0.1853	3.8
770	3188EC771T350AM	EC	0.1406	4.7
960	3188ED961T350AM	ED	0.1141	5.5
1100	3188EE112T350AM	EE	0.0988	6.3
1300	3188EF132T350AM	EF	0.0852	7.1
1500	3188EG152T350AM	EG	0.0751	7.8
1600	3188EH162T350AM	EH	0.0686	8.5
940	3188FB941T350AM	FB	0.1585	4.8
1200	3188FC122T350AM	FC	0.1274	5.7
1600	3188FD162T350AM	FD	0.1016	6.7
1900	3188FE192T350AM	FE	0.0550	9.6
2200	3188FF222T350AM	FF	0.0481	10.7
2500	3188FG252T350AM	FG	0.0428	11.8
2900	3188FH292T350AM	FH	0.0379	13.1
1900	3188GC192T350AM	GC	0.0648	9.0
2300	3188GD232T350AM	GD	0.0533	10.4
2800	3188GE282T350AM	GE	0.0450	11.9
3300	3188GF332T350AM	GF	0.0392	13.3
3800	3188GG382T350AM	GG	0.0348	14.7
4300	3188GH432T350AM	GH	0.0315	16.0
6900	3188GN692T350AM	GN	0.0218	22.9

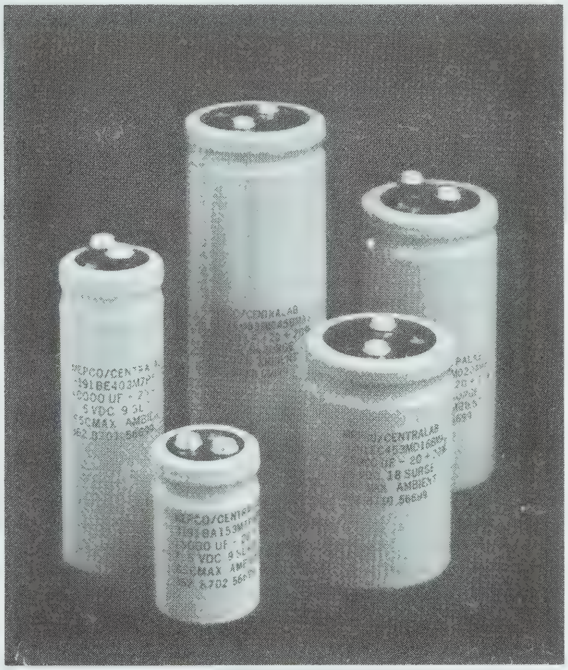
400.0 VDC WORKING 450.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR OHMS 120HZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 120HZ,85C
180	3188BA181T400AM	BA	0.4506	1.8
220	3188BB221T400AM	BB	0.3702	2.2
300	3188BC301T400AM	BC	0.2764	2.7
380	3188BD381T400AM	BD	0.2198	3.2
450	3188BE451T400AM	BE	0.1865	3.7
530	3188BF531T400AM	BF	0.1595	4.2
610	3188BG611T400AM	BG	0.1397	4.6
680	3188BH681T400AM	BH	0.1260	5.1
330	3188DA331T400AM	DA	0.2709	2.7
390	3188DB391T400AM	DB	0.2294	3.2
540	3188DC541T400AM	DC	0.1714	3.9
680	3188DD681T400AM	DD	0.1378	4.6
820	3188DE821T400AM	DE	0.1157	5.3
950	3188DF951T400AM	DF	0.1007	6.0
1000	3188DG102T400AM	DG	0.0944	6.5
1100	3188DH112T400AM	DH	0.0852	7.1
430	3188EA431T400AM	EA	0.2262	3.2
510	3188EB511T400AM	EB	0.1909	3.8
710	3188EC711T400AM	EC	0.1437	4.7
880	3188ED881T400AM	ED	0.1169	5.5
1000	3188EE102T400AM	EE	0.1018	6.2
1200	3188EF122T400AM	EF	0.0869	7.0
1300	3188EG132T400AM	EG	0.0665	8.3
1500	3188EH152T400AM	EH	0.0590	9.2
860	3188FB861T400AM	FB	0.1618	4.8
1100	3188FC112T400AM	FC	0.1300	5.6
1400	3188FD142T400AM	FD	0.0684	8.2
1700	3188FE172T400AM	FE	0.0574	9.4
2000	3188FF202T400AM	FF	0.0496	10.6
2300	3188FG232T400AM	FG	0.0438	11.7
2600	3188FH262T400AM	FH	0.0394	12.8
1700	3188GC172T400AM	GC	0.0670	8.8
2100	3188GD212T400AM	GD	0.0547	10.3
2600	3188GE262T400AM	GE	0.0459	11.8
3000	3188GF302T400AM	GF	0.0402	13.1
3500	3188GG352T400AM	GG	0.0356	14.5
3900	3188GH392T400AM	GH	0.0323	15.8
6300	3188GN632T400AM	GN	0.0223	22.7

SERIES 3191

Computer-Grade Aluminum Electrolytic Capacitors

Symmetrical-Tolerance Capacitors for Switch-Mode Power Supplies.



DESCRIPTION:

Series 3191 Computer-Grade Aluminum Electrolytic Capacitors are specifically designed for use in switch-mode power supplies. Their construction utilizes the most advanced multiple-tabbing techniques and a non-acqueous electrolyte system to attain extremely low ESR, high ripple-current capability and long life. These same attributes make them an excellent choice for any filtering application.

FEATURES:

- 5 VDC to 55 VDC ratings.
- Very Low ESR—3.8 milliohms at 20 kHz (200000 μF and 5 VDC).
- Symmetrical ESR Tolerance—±30%.
- Symmetrical Capacitance Tolerance—±20%.
- High Ripple Current Capability—up to 30 amps in a 2.0″ x 5.625″ case at 85°C.

SERIES 3191

5.0 VDC WORKING 6.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR (OHMS) 120HZ,25C	±30% ESR (MOHMS) 20KHZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 20KHZ,85C
18000	3191BA183M005BM	BA	0.0154	9.5	9.4
25000	3191BB253M005BM	BB	0.0129	8.3	11.0
32000	3191BC323M005BM	BC	0.0106	7.1	12.7
39000	3191BD393M005BM	BD	0.0093	6.4	14.2
46000	3191BE463M005BM	BE	0.0085	5.9	15.6
53000	3191BF533M005BM	BF	0.0075	5.2	17.5
60000	3191BG603M005BM	BG	0.0070	5.0	18.7
67000	3191BH673M005BM	BH	0.0067	4.8	19.8
57000	3191EA573M005BM	EA	0.0119	7.0	13.9
69000	3191EB693M005BM	EB	0.0103	6.2	15.9
92000	3191EC923M005BM	EC	0.0084	5.2	18.5
110000	3191ED114M005BM	ED	0.0072	4.7	20.7
130000	3191EE134M005BM	EE	0.0065	4.3	22.7
160000	3191EF164M005BM	EF	0.0060	4.1	24.5
180000	3191EG184M005BM	EG	0.0057	3.9	26.1
200000	3191EH204M005BM	EH	0.0054	3.8	27.5

7.5 VDC WORKING 9.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR (OHMS) 120HZ,25C	±30% ESR (MOHMS) 20KHZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 20KHZ,85C
15000	3191BA153M7P5BM	BA	0.0158	9.6	9.4
21000	3191BB213M7P5BM	BB	0.0131	8.3	10.9
27000	3191BC273M7P5BM	BC	0.0108	7.1	12.7
33000	3191BD333M7P5BM	BD	0.0094	6.4	14.2
39000	3191BE393M7P5BM	BE	0.0086	6.0	15.5
45000	3191BF453M7P5BM	BF	0.0076	5.2	17.5
51000	3191BG513M7P5BM	BG	0.0071	5.0	18.7
57000	3191BH573M7P5BM	BH	0.0068	4.8	19.7
48000	3191EA483M7P5BM	EA	0.0121	7.0	13.9
58000	3191EB583M7P5BM	EB	0.0105	6.2	15.9
76000	3191EC763M7P5BM	EC	0.0085	5.3	18.5
95000	3191ED953M7P5BM	ED	0.0074	4.7	20.7
110000	3191EE114M7P5BM	EE	0.0066	4.3	22.7
130000	3191EF134M7P5BM	EF	0.0061	4.1	24.5
150000	3191EG154M7P5BM	EG	0.0057	3.9	26.1
170000	3191EH174M7P5BM	EH	0.0054	3.8	27.5

10.0 VDC WORKING 12.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR (OHMS) 120HZ,25C	±30% ESR (MOHMS) 20KHZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 20KHZ,85C
16000	3191BA163M010BM	BA	0.0153	9.3	9.5
19000	3191BB193M010BM	BB	0.0133	8.3	10.9
25000	3191BC253M010BM	BC	0.0109	7.0	12.7
31000	3191BD313M010BM	BD	0.0095	6.3	14.3
38000	3191BE383M010BM	BE	0.0086	5.9	15.6
44000	3191BF443M010BM	BF	0.0075	5.1	17.6
51000	3191BG513M010BM	BG	0.0071	4.9	18.8
57000	3191BH573M010BM	BH	0.0067	4.8	19.9
38000	3191EA383M010BM	EA	0.0119	7.1	13.8
46000	3191EB463M010BM	EB	0.0104	6.3	15.8
61000	3191EC613M010BM	EC	0.0084	5.3	18.4
76000	3191ED763M010BM	ED	0.0073	4.7	20.6
92000	3191EE923M010BM	EE	0.0066	4.4	22.6
100000	3191EF104M010BM	EF	0.0060	4.1	24.3
120000	3191EG124M010BM	EG	0.0057	3.9	26.0
130000	3191EH134M010BM	EH	0.0054	3.8	27.4

16.0 VDC WORKING 18.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR (OHMS) 120HZ,25C	±30% ESR (MOHMS) 20KHZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 20KHZ,85C
10000	3191BA103M016BM	BA	0.0167	9.6	9.3
14000	3191BB143M016BM	BB	0.0138	8.4	10.9
18000	3191BC183M016BM	BC	0.0113	7.1	12.6
22000	3191BD223M016BM	BD	0.0098	6.4	14.2
26000	3191BE263M016BM	BE	0.0089	6.0	15.5
30000	3191BF303M016BM	BF	0.0079	5.2	17.4
34000	3191BG343M016BM	BG	0.0074	5.0	18.6
38000	3191BH383M016BM	BH	0.0070	4.9	19.7
26000	3191EA263M016BM	EA	0.0121	7.2	13.7
32000	3191EB323M016BM	EB	0.0105	6.4	15.7
43000	3191EC433M016BM	EC	0.0086	5.4	18.3
53000	3191ED533M016BM	ED	0.0074	4.8	20.5
64000	3191EE643M016BM	EE	0.0066	4.4	22.5
75000	3191EF753M016BM	EF	0.0061	4.1	24.3
86000	3191EG863M016BM	EG	0.0057	4.0	25.9
96000	3191EH963M016BM	EH	0.0055	3.8	27.4

20.0 VDC WORKING 22.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR (OHMS) 120HZ,25C	±30% ESR (MOHMS) 20KHZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 20KHZ,85C
8800	3191BA882M020BM	BA	0.0173	9.8	9.3
12000	3191BB123M020BM	BB	0.0142	8.5	10.8
16000	3191BC163M020BM	BC	0.0115	7.2	12.6
20000	3191BD203M020BM	BD	0.0100	6.5	14.1
22000	3191BE223M020BM	BE	0.0093	6.1	15.4
27000	3191BF273M020BM	BF	0.0080	5.3	17.4
30000	3191BG303M020BM	BG	0.0075	5.1	18.5
34000	3191BH343M020BM	BH	0.0071	4.9	19.6
23000	3191EA233M020BM	EA	0.0121	7.3	13.7
27000	3191EB273M020BM	EB	0.0105	6.5	15.6
37000	3191EC373M020BM	EC	0.0086	5.4	18.2
46000	3191ED463M020BM	ED	0.0074	4.8	20.5
55000	3191EE553M020BM	EE	0.0066	4.4	22.4
64000	3191EF643M020BM	EF	0.0061	4.2	24.2
74000	3191EG743M020BM	EG	0.0057	4.0	25.8
83000	3191EH833M020BM	EH	0.0055	3.9	27.3

28.0 VDC WORKING 32.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR (OHMS) 120HZ,25C	±30% ESR (MOHMS) 20KHZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 20KHZ,85C
6300	3191BA622M028BM	BA	0.0213	12.1	8.3
8800	3191BB882M028BM	BB	0.0170	10.1	9.9
11000	3191BC113M028BM	BC	0.0140	8.5	11.6
14000	3191BD143M028BM	BD	0.0119	7.5	13.1
16000	3191BE163M028BM	BE	0.0108	6.9	14.4
19000	3191BF193M028BM	BF	0.0094	6.0	16.2
22000	3191BG223M028BM	BG	0.0086	5.7	17.5
24000	3191BH243M028BM	BH	0.0082	5.5	18.6
15000	3191EA153M028BM	EA	0.0127	7.4	13.5
18000	3191EB183M028BM	EB	0.0110	6.6	15.5
24000	3191EC243M028BM	EC	0.0089	5.5	18.1
30000	3191ED303M028BM	ED	0.0077	4.9	20.3
36000	3191EE363M028BM	EE	0.0069	4.5	22.3
42000	3191EF423M028BM	EF	0.0063	4.2	24.1
48000	3191EG483M028BM	EG	0.0059	4.0	25.7
54000	3191EH543M028BM	EH	0.0056	3.9	27.2

35.0 VDC WORKING 40.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR (OHMS) 120HZ,25C	±30% ESR (MOHMS) 20KHZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 20KHZ,85C
4500	3191BA442M035BM	BA	0.0235	12.4	8.2
6300	3191BB622M035BM	BB	0.0185	10.4	9.8
8100	3191BC802M035BM	BC	0.0150	8.7	11.5
10000	3191BD103M035BM	BD	0.0129	7.7	13.0
12000	3191BE123M035BM	BE	0.0114	7.0	14.3
14000	3191BF143M035BM	BF	0.0100	6.1	16.1
16000	3191BG163M035BM	BG	0.0092	5.8	17.4
17000	3191BH173M035BM	BH	0.0088	5.6	18.4
11000	3191EA113M035BM	EA	0.0135	7.5	13.4
13000	3191EB133M035BM	EB	0.0116	6.7	15.4
17000	3191EC173M035BM	EC	0.0094	5.6	17.9
22000	3191ED223M035BM	ED	0.0081	4.9	20.2
26000	3191EE263M035BM	EE	0.0072	4.5	22.2
31000	3191EF313M035BM	EF	0.0066	4.3	24.0
35000	3191EG353M035BM	EG	0.0062	4.1	25.6
40000	3191EH403M035BM	EH	0.0058	3.9	27.1

45.0 VDC WORKING 50.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR (OHMS) 120HZ,25C	±30% ESR (MOHMS) 20KHZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 20KHZ,85C
3800	3191BA382M045BM	BA	0.0270	14.5	7.6
4600	3191BB462M045BM	BB	0.0230	12.5	8.9
6200	3191BC622M045BM	BC	0.0180	10.2	10.6
7700	3191BD762M045BM	BD	0.0152	8.9	12.1
9300	3191BE922M045BM	BE	0.0133	8.0	13.4
10000	3191BF103M045BM	BF	0.0121	7.1	14.9
12000	3191BG123M045BM	BG	0.0108	6.6	16.3
14000	3191BH143M045BM	BH	0.0099	6.2	17.5
9300	3191EA922M045BM	EA	0.0148	8.5	12.6
11000	3191EB113M045BM	EB	0.0128	7.5	14.5
14000	3191EC143M045BM	EC	0.0103	6.3	16.9
18000	3191ED183M045BM	ED	0.0088	5.5	19.2
22000	3191EE223M045BM	EE	0.0078	5.0	21.2
26000	3191EF263M045BM	EF	0.0071	4.6	23.0
29000	3191EG293M045BM	EG	0.0066	4.4	24.6
33000	3191EH333M045BM	EH	0.0062	4.2	26.1

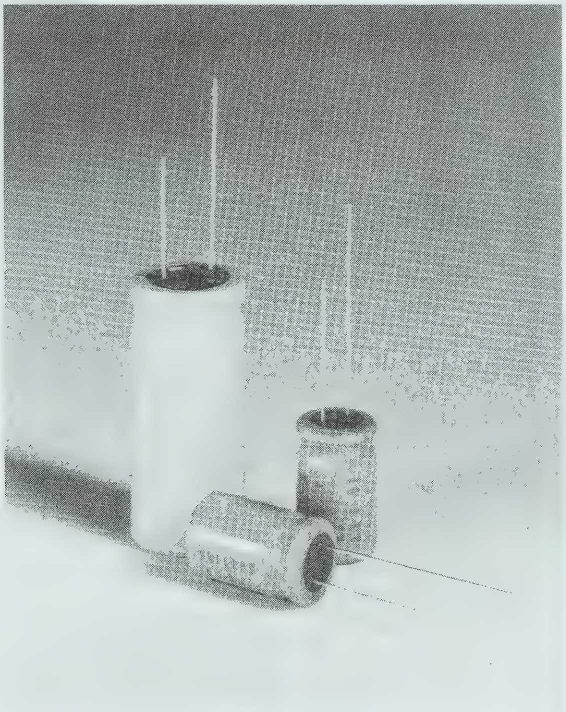
SERIES 3191

55.0 VDC WORKING 64.0 SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE CODE	MAXIMUM ESR (OHMS) 120HZ,25C	±30% ESR (MOHMS) 20KHZ,25C	MAX. RMS RIPPLE CURRENT AMPS AT 20KHZ,85C
2800	3191BA282M055BM	BA	0.0302	15.0	7.5
3900	3191BB382M055BM	BB	0.0233	12.3	9.0
5000	3191BC502M055BM	BC	0.0188	10.2	10.6
6200	3191BD622M055BM	BD	0.0159	8.9	12.1
7300	3191BE722M055BM	BE	0.0141	8.1	13.4
8400	3191BF842M055BM	BF	0.0124	7.0	15.0
9500	3191BG942M055BM	BG	0.0114	6.6	16.2
10000	3191BH103M055BM	BH	0.0109	6.4	17.2
7300	3191EA722M055BM	EA	0.0157	8.6	12.6
8800	3191EB882M055BM	EB	0.0135	7.5	14.5
11000	3191EC113M055BM	EC	0.0109	6.3	16.9
14000	3191ED143M055BM	ED	0.0092	5.5	19.1
17000	3191EE173M055BM	EE	0.0082	5.0	21.1
20000	3191EF203M055BM	EF	0.0074	4.7	22.9
23000	3191EG233M055BM	EG	0.0069	4.4	24.6
26000	3191EH263M055BM	EH	0.0065	4.2	26.1

SERIES 3476

Miniature Single-Ended Aluminum Electrolytic Capacitors



DESCRIPTION:

The Philips Components Series 3476 is a general purpose Single-Ended Aluminum Electrolytic Capacitor. Theses capacitors are suitable for use in timing and delay circuits as well as filitering, coupling, and decoupling.

Series 3476 capacitors are supplied as polar units available in 13 case sizes, ranging from 5x11mm to 18x40mm.

FEATURES:

- Capacitance tolerance ±20%.
- Smaller size allows wider choice of capacitance and voltage for automatic insertion.
- Low leakage current.
- With the exception of 5mm diameter cans, all capacitors have safety vents.
- Max Operating Temperature +85°C.
- Capacitance Range 0.47 to 10,000 μF.
- Rated Voltage Range 6.3 to 450V.
- Halogenated Solvent Proof Configuration available, 6.3 to 100V.

For Application Guidelines see pages 82-91

SERIES 3476

Miniature Single-Ended Aluminum Electrolytic Capacitors

1

Aluminum Electrolytic Capacitors

CHARACTERISTICS

Item	Characteristic	
Voltage Range	**100V, DC or less**	**160～450V, DC**
Operating Temperature Range	−40～+85°C	−25～85°C
Capacitance Tolerance	±20% (M) (−10～+30% (S)…Non-standard) (at 20°C, 120Hz)	
Leakage Current	The following specifications shall be satisfied when the rated voltage is applied for the required time. After 1 minute : 0.03CV (μA) or 4 μA, whichever is greater After 2 minutes: 0.01CV (μA) or 3 μA, whichever is greater Where C=Nominal capacitance (μF) V=Rated voltage (V) (at 20°C)	After 1 minute : 0.1CV +40 (μA) (CV≦1000) 0.04CV + 100 (μA) (CV>1000) After 5 minutes: 0.03CV + 15 (μA) (CV≦1000) 0.02CV + 25 (μA) (CV>1000)

Dissipation Factor (Tan δ)

Rated voltage (V)	6.3	10	16	25	35	50	63～80	100	160～315	350～450
Tan δ	0.24	0.20	0.16	0.14	0.12	0.10	0.08	0.07	0.20	0.24

For capacitors whose rated voltage is 100V or less and whose capacitance exceeds 1,000μF, the specification of tanδ is increased by 0.02 for every addition of 1,000μF. (at 20°C, 120Hz)

Surge Voltage

Rated voltage (V)	6.3	10	16	25	35	50	63	80	100	160	200	250	315	350	400	450
Surge voltage (V)	8	13	20	32	44	63	79	100	125	200	250	300	365	400	450	500

Temperature Characteristics

Impedance ratio at 120Hz

Rated voltage (V)	6.3	10	16	25	35	50	63	80	100	160	200, 250	315, 350	400, 450
Z-25°C/Z20°C	4	3	2	2	2	2	2	2	2	4	8	12	16
Z-40°C/Z20°C	10	8	6	4	3	3	3	3	3	–	–	–	–

Load Life

100V, DC or less: The following specifications shall be satisfied when the capacitors are restored to 20°C after the rated voltage applied for 1,000 hours at 85°C.

Capacitance change (%) from initial value

V \ Case diameter	≦φ6.3	>φ6.3
6.3～16V	±20%	
25～100V	±20%	±15%

Tan δ≦150% of initial specified value
Leakage current ≦ initial specified value

160～450V, DC: The following specifications shall be satisfied when the capacitors are restored to 20°C after the rated voltage applied for 1,000 hours at 85°C.
Capacitance change ≦±20% of initial value
Dissipation factor ≦150% of initial specified value
Leakage current ≦ initial specified value

Shelf Life

100V, DC or less: The following specifications shall be satisfied when the capacitors are restored to 20°C after exposing them at 85°C for 1,000 hours without voltage applied.
Capacitance change value shall be within the specifications shown on the table of load life.
Tan δ≦150% of initial specified value
Leakage current ≦initial specified value

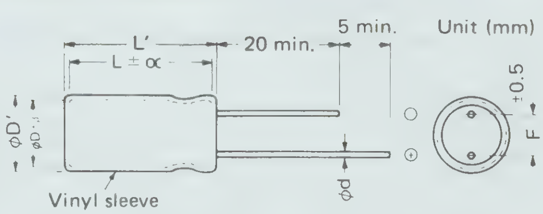
160～450V, DC: The following specifications shall be satisfied when the capacitors are restored to 20°C after exposing them at 85°C for 500 hours without voltage applied.
Capacitance change ≦±20% of initial value
Dissipation factor ≦150% of initial specified value
Leakage current ≦200% of initial specified value

Others: Satisfies characteristic W of JIS C5141* Tested Methods per JIS 5102**

*May be ordered from American National Standards Institute. **A Summery of these standards appears on page127

CASE OUTLINE DRAWING

D	F	d
5	2	0.5
6.3	2.5	0.6
8	3.5	0.6
10	5	0.6
12.5	5	0.6
16	7.5	0.8
18	7.5	0.8



When D≦ 12.5, D'≦ D + 0.5 and L' ≦ L + 1.5
When D> 12.5, D'≦ D + 0.5 and L' ≦ L + 2.0
For L≦10, α = 1 For D≦10, β = 0.5
For L > 10, α = 2 For D > 10, β = 1

CASE DIMENSIONS

Case Code	Diameter (mm)	Length (mm)	Case Code	Diameter (mm)	Length (mm)
CB	5.0	11.0	HG	12.5	25.0
DB	6.3	11.0	KG	16.0	25.0
FC	8.0	11.5	KJ	16.0	31.5
GC	10.0	12.5	KL	16.0	35.5
GD	10.0	16.0	LL	18.0	35.5
GF	10.0	20.0	LK	18.0	40.0
HF	12.5	20.0			

See page 127 for mm to inches conversion table.

Note: With the exception of 5mm diameter cans, all 3476 capacitors have a safety vent.

SERIES 3476
Miniature Single-Ended Aluminum Electrolytic Capacitors

CASE SIZE OF STANDARD PRODUCTS

D x L (mm)

V / μF	6.3	10	16	25	35	50	63	80	100	160	200	250	350	450
0.47						5x11			5x11	6.3x11			10x16	
1						5x11			5x11	6.3x11		10x16	10x16	10x16
2.2						5x11	5x11		5x11	8x11.5		10x16	10x16	10x20
3.3						5x11	5x11		5x11	10x16	10x16	10x16	10x20	12.5x20
4.7				5x11	5x11	5x11	5x11		6.3x11	10x16	10x16	10x16	10x20	12.5x25
10			5x11	5x11	5x11	5x11	6.3x11		8x11.5	10x16	10x20	12.5x20	12.5x25	16x25
22		5x11	5x11	5x11	6.3x11	6.3x11	8x11.5	10x12.5	10x12.5	12.5x20	12.5x20	12.5x25	16x25	
33	5x11	5x11	5x11	6.3x11	6.3x11	8x11.5	8x11.5	10x16	10x16	12.5x25	16x25	16x25	16.35.5	
47	5x11	5x11	6.3x11	6.3x11	8x11.5	8x11.5	10x12.5	10x16	10x20	16x25	16x25	16x35.5		
100	6.3x11	6.3x11	8x11.5	8x11.5	10x12.5	10x16	10x20	12.5x20	12.5x20	16x35.5	18x40			
220	8x11.5	8x11.5	10x12.5	10x16	10x20	12.5x20	12.5x20	12.5x25	16x25					
330	10x12.5	10x12.5	10x16	10x20	12.5x20	12.5x20	12.5x25	16x31.5	16x31.5					
470	10x12.5	10x16	10x20	12.5x20	12.5x25	16x25	16x25	16x35.5	18x35.5					
1000	10x20	12.5x20	12.5x25	16x25	16x25	16x31.5	18x35.5							
2200	12.5x25	16x25	16x25	16x35.5	18x35.5									
3300	16x25	16x31.5	16x35.5	18x40										
4700	16x31.5	16x35.5	18x35.5											
6800	16x35.5	18x40												
10000	18x40													

STANDARD CAPACITANCE VALUES

Capacitance μF	Philips Components Part Number	Case Code	Maximum ESR (OHMS) 120Hz, 25°C	Max. RMS Ripple Current AMPS at 120Hz, 85°C
6.3VDC WORKING, 8VDC SURGE				
33	3476CB330M6P3JMBS	CB	12.057	0.044
47	3476CB470M6P3JMBS	CB	8.466	0.054
100	3476DB101M6P3JMBS	DB	3.979	0.090
220	3476FC221M6P3JMBS	FC	1.809	0.155
330	3476GC331M6P3JMBS	GC	1.206	0.222
470	3476GC471M6P3JMBS	GC	.846	0.265
1000	3476GF102M6P3JMBS	GF	.396	0.460
2200	3476HG222M6P3JMBS	HG	.196	0.787
3300	3476KG332M6P3JMBS	KG	.141	1.027
4700	3476KJ472M6P3JMBS	KJ	.106	1.270
6800	3476KL682M6P3JMBS	KL	.088	1.674
10000	3476LK103M6P3JMBS	LK	.070	2.037
10VDC WORKING, 13VDC SURGE				
22	3476CB220M010JMBS	CB	15.071	0.051
33	3476CB330M010JMBS	CB	10.048	0.068
47	3476CB470M010JMBS	CB	7.055	0.084
100	3476DB101M010JMBS	DB	3.316	0.140
220	3476FC221M010JMBS	FC	1.508	0.240
330	3476GC331M010JMBS	GC	1.005	0.320
470	3476GD471M010JMBS	GD	.705	0.410
1000	3476HF102M010JMBS	HF	.331	0.640
2200	3476KG222M010JMBS	KG	.166	0.946
3300	3476KJ332M010JMBS	KJ	.120	1.189
4700	3476KL472M010JMBS	KL	.091	1.410
6800	3476LK682M010JMBS	LK	.078	1.959

Capacitance μF	Philips Components Part Number	Case Code	Maximum ESR (OHMS) 120Hz, 25°C	Max. RMS Ripple Current AMPS at 120Hz, 85°C
16VDC WORKING, 20VDC SURGE				
10	3476CB100M016JMBS	CB	26.525	0.031
22	3476CB220M016JMBS	CB	12.062	0.055
33	3476CB330M016JMBS	CB	8.038	0.073
47	3476DB470M016JMBS	DB	5.650	0.094
100	3476FC101M016JMBS	FC	2.650	0.160
220	3476GC221M016JMBS	GC	1.213	0.285
330	3476GD331M016JMBS	GD	.800	0.385
470	3476GF471M016JMBS	GF	.563	0.480
1000	3476HG102M016JMBS	HG	.263	0.780
2200	3476KG222M016JMBS	KG	.138	1.120
3300	3476KL332M016JMBS	KL	.100	1.347
4700	3476LL472M016JMBS	LL	.078	1.585
25VDC WORKING, 32VDC SURGE				
4.7	3476CB479M025JMBS	CB	49.388	0.022
10	3476CB100M025JMBS	CB	23.213	0.040
22	3476CB220M025JMBS	CB	10.550	0.069
33	3476DB330M025JMBS	DB	7.038	0.090
47	3476DB470M025JMBS	DB	4.938	0.110
100	3476FC101M025JMBS	FC	2.325	0.170
220	3476GD221M025JMBS	GD	1.050	0.320
330	3476GF331M025JMBS	GF	.700	0.450
470	3476HF471M025JMBS	HF	.500	0.580
1000	3476KG102M025JMBS	KG	.238	0.920
2200	3476KL222M025JMBS	KL	.120	1.300
3300	3476LK332M025JMBS	LK	.090	1.560

SERIES 3476

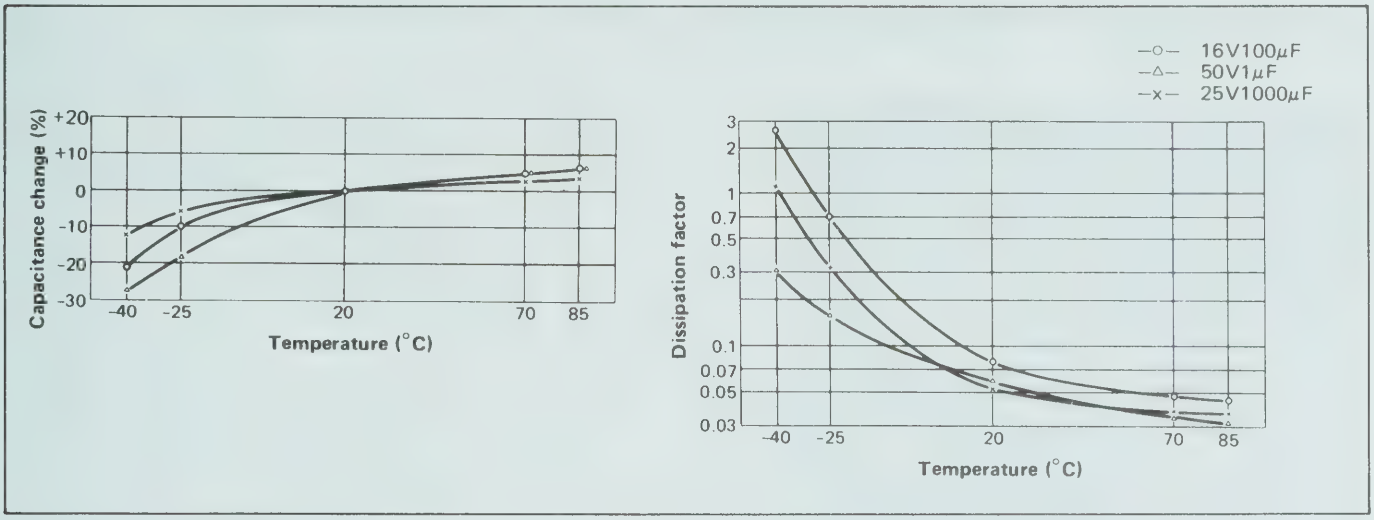
Miniature Single-Ended Aluminum Electrolytic Capacitors

STANDARD CAPACITANCE VALUES

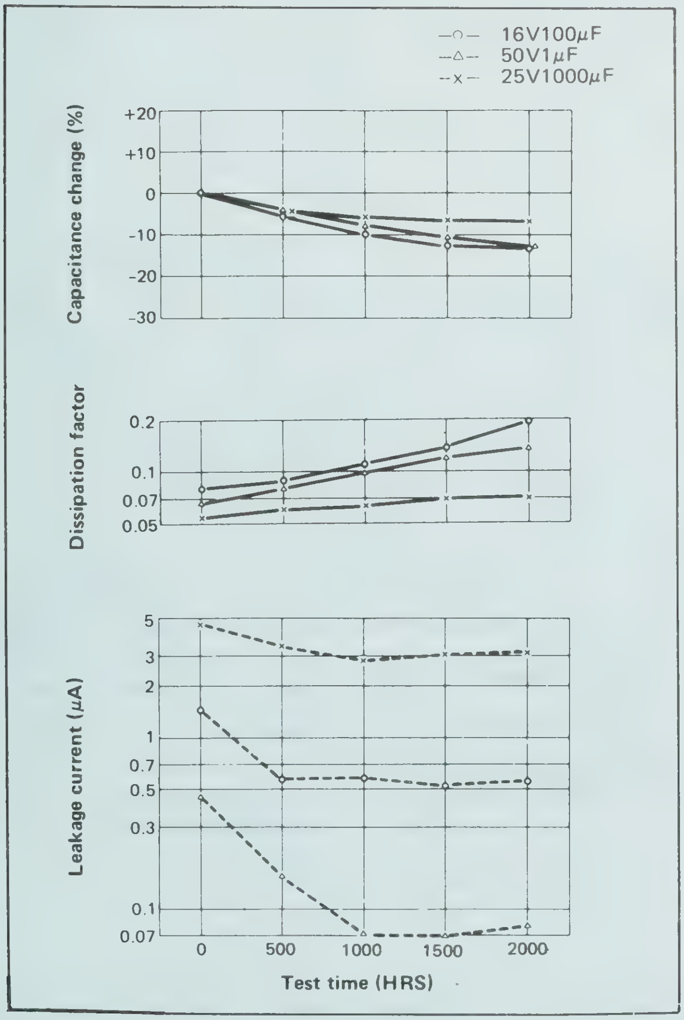
Capacitance µF	PHILIPS COMPONENTS Part Number	Case Code	Maximum ESR (OHMS) 120Hz, 25°C	Max. RMS Ripple Current AMPS at 120Hz, 85°C
35VDC WORKING, 44VDC SURGE				
4.7	3476CB479M035JMBS	CB	42.325	0.026
10	3476CB100M035JMBS	CB	19.900	0.044
22	3476DB220M035JMBS	DB	9.038	0.076
33	3476DB330M035JMBS	DB	6.025	0.100
47	3476FC470M035JMBS	FC	4.238	0.135
100	3476GC101M035JMBS	GC	1.988	0.230
220	3476GF221M035JMBS	GF	.900	0.400
330	3476HF331M035JMBS	HF	.600	0.520
470	3476HG471M035JMBS	HG	.425	0.760
1000	3476KG102M035JMBS	KG	.200	1.050
2200	3476LL222M035JMBS	LL	.105	1.359
50VDC WORKING, 63VDC SURGE				
0.47	3476CB478M050JMBS	CB	352.739	0.006
1	3476CB109M050JMBS	CB	165.788	0.013
2.2	3476CB229M050JMBS	CB	75.363	0.023
3.3	3476CB339M050JMBS	CB	50.238	0.029
4.7	3476CB479M050JMBS	CB	35.275	0.035
10	3476CB100M050JMBS	CB	16.575	0.051
22	3476DB220M050JMBS	DB	7.538	0.080
33	3476FC330M050JMBS	FC	5.025	0.105
47	3476FC470M050JMBS	FC	3.525	0.140
100	3476GD101M050JMBS	GD	1.663	0.250
220	3476HF221M050JMBS	HF	.750	0.450
330	3476HF331M050JMBS	HF	.500	0.600
470	3476KG471M050JMBS	KG	.350	0.800
1000	3476KJ102M050JMBS	JK	.166	1.350
63VDC WORKING, 79VDC SURGE				
2.2	3476CB229M063JMBS	CB	60.288	0.027
3.3	3476CB339M063JMBS	CB	40.188	0.035
4.7	3476CB479M063JMBS	CB	28.225	0.044
10	3476DB100M063JMBS	DB	13.263	0.070
22	3476FC220M063JMBS	FC	6.025	0.110
33	3476FC330M063JMBS	FC	4.025	0.140
47	3476GC470M063JMBS	GC	2.825	0.180
100	3476GF101M063JMBS	GF	1.325	0.300
220	3476HF221M063JMBS	HF	.600	0.520
330	3476HG331M063JMBS	HG	.400	0.700
470	3476KG471M063JMBS	KG	.288	0.920
1000	3476LL102M063JMBS	LL	.133	1.550
80VDC WORKING, 100VDC SURGE				
22	3476GC220M080JMBS	GC	6.025	0.130
33	3476GD330M080JMBS	GD	4.025	0.180
47	3476GD470M080JMBS	GD	2.825	0.195
100	3476HF101M080JMBS	HF	1.325	0.330
220	3476HG221M080JMBS	HG	.600	0.565
330	3476KJ331M080JMBS	KJ	.400	0.825
470	3476KL471M080JMBS	KL	.283	1.020
100VDC WORKING, 125VDC SURGE				
0.47	3476CB478M100JMBS	CB	246.66	0.010
1	3476CB109M100JMBS	CB	116.05	0.018
2.2	3476CB229M100JMBS	CB	52.75	0.031
3.3	3476CB339M100JMBS	CB	35.16	0.041
4.7	3476DB479M100JMBS	DB	24.68	0.052

Capacitance µF	PHILIPS COMPONENTS Part Number	Case Code	Maximum ESR (OHMS) 120Hz, 25°C	Max. RMS Ripple Current AMPS at 120Hz, 85°C
100VDC WORKING, 125VDC SURGE				
10	3476FC100M100JMBS	FC	11.600	0.088
22	3476GC220M100JMBS	GC	5.275	0.145
33	3476GD330M100JMBS	GD	3.513	0.190
47	3476GF470M100JMBS	GF	2.475	0.235
100	3476HF101M100JMBS	HF	1.163	0.390
220	3476KG221M100JMBS	KG	.525	0.720
330	3476KJ331M100JMBS	KJ	.350	0.980
470	3476LL471M100JMBS	LL	.248	1.300
160VDC WORKING, 200VDC SURGE				
0.47	3476DB478M160JMBS	DB	705.47	0.0067
1	3476DB109M160JMBS	DB	331.57	0.0098
2.2	3476FC229M160JMBS	FC	150.71	0.016
3.3	3476GD339M160JMBS	GD	100.41	0.026
4.7	3476GD479M160JMBS	GD	70.55	0.031
10	3476GD100M160JMBS	GD	33.16	0.046
22	3476HF220M160JMBS	HF	15.07	0.082
33	3476HG330M160JMBS	HG	10.05	0.110
47	3476KG470M160JMBS	KG	7.05	0.145
100	3476KL101M160JMBS	KL	3.313	0.234
200VDC WORKING, 250VDC SURGE				
3.3	3476GD339M200JMBS	GD	100.47	0.026
4.7	3476GD479M200JMBS	GD	70.55	0.031
10	3476GF100M200JMBS	GF	33.16	0.050
22	3476HF220M200JMBS	HF	15.07	0.082
33	3476KG330M200JMBS	KG	10.05	0.122
47	3476KG470M200JMBS	KG	7.05	0.145
100	3476LK101M200JMBS	LK	3.313	0.248
250VDC WORKING, 300VDC SURGE				
1	3476GD109M250JMBS	GD	331.57	0.014
2.2	3476GD229M250JMBS	GD	150.71	0.021
3.3	3476GD339M250JMBS	GD	100.47	0.026
4.7	3476GD479M250JMBS	GD	70.56	0.031
10	3476HF100M250JMBS	HF	33.16	0.055
22	3476HG220M250JMBS	HG	15.07	0.090
33	3476KG330M250JMBS	KG	10.05	0.122
47	3476KJ470M250JMBS	KJ	7.05	0.156
350VDC WORKING, 400VDC SURGE				
0.47	3476GD478M350JMBS	GD	846.58	0.0092
1	3476GD109M350JMBS	GD	397.89	0.013
2.2	3476GD229M350JMBS	GD	180.86	0.019
3.3	3476GF339M350JMBS	GF	120.58	0.024
4.7	3476GF479M350JMBS	GF	84.66	0.031
10	3476HG100M350JMBS	HG	39.79	0.051
22	3476KG220M350JMBS	KG	18.09	0.091
33	3476KL330M350JMBS	KL	12.06	0.122
450VDC WORKING, 500VDC SURGE				
1	3476GD109M450JMBS	GD	397.89	0.013
2.2	3476GF229M450JMBS	GF	180.86	0.021
3.3	3476HF339M450JMBS	HF	120.58	0.029
4.7	3476HG479M450JMBS	HG	84.66	0.038
10	3476KG100M450JMBS	KG	39.79	0.061

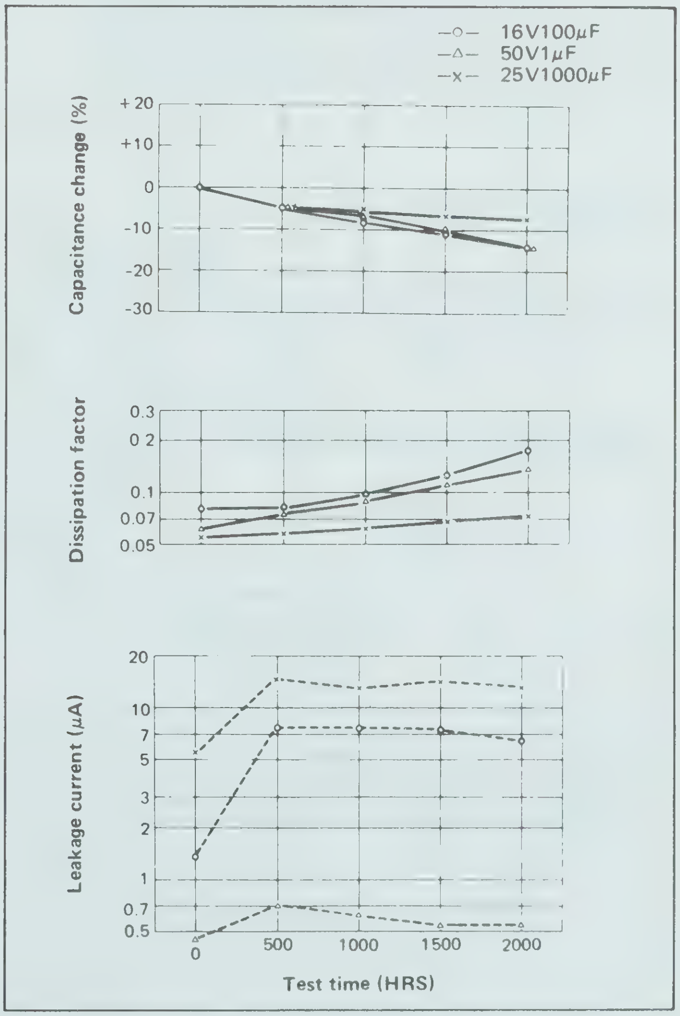
TEMPERATURE CHARACTERISTICS



85°C LOAD LIFE



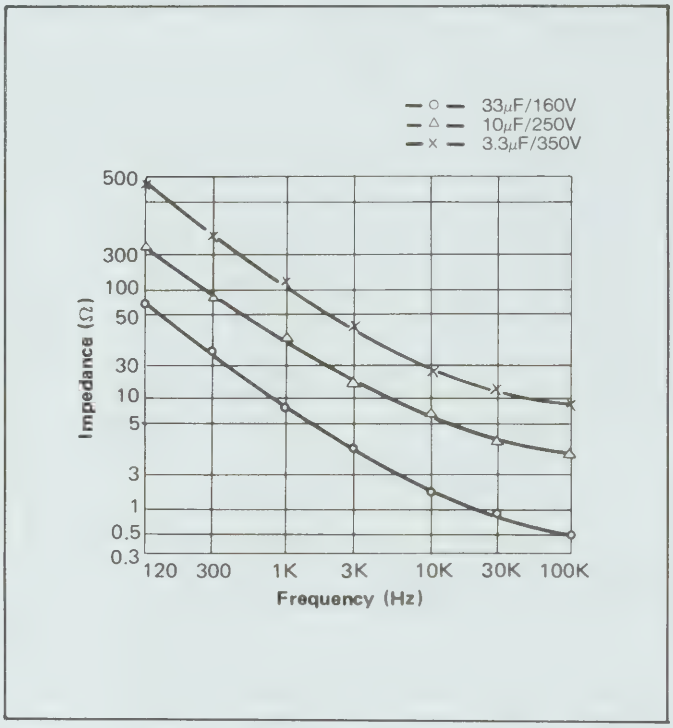
85°C SHELF LIFE



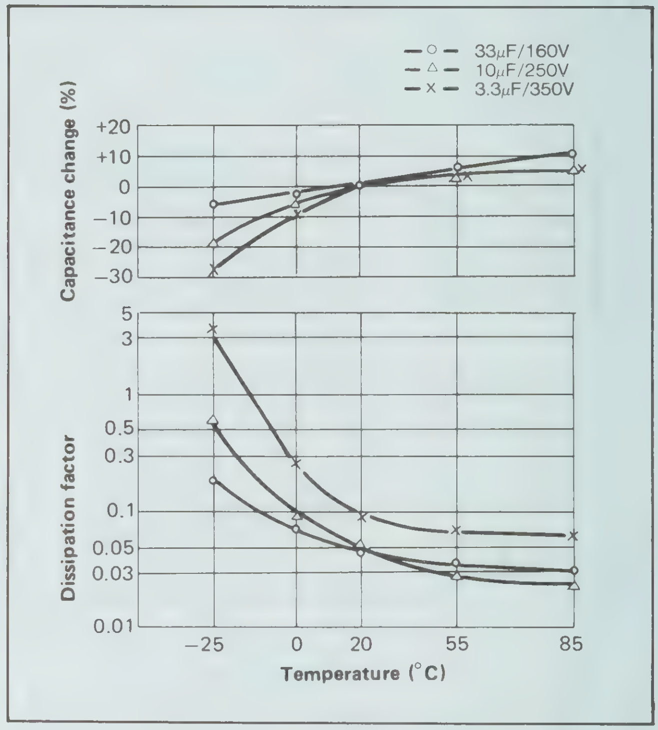
SERIES 3476

Miniature Single-Ended Aluminum Electrolytic Capacitors

TEMPERATURE CHARACTERISTICS



IMPEDANCE



HOW TO SPECIFY

Philips Components Series 3476 Capacitors can be completely specified using the following designation:

3476 GF 471 M 016 J M B S

3476 — Philips Components Product Series

GF — Case Size Code (see physical spec)

471 — Capacitance
XX=Significant Digits
X=Multiplier
i.e. 471=470μF
470= 47μF
478=.47μF

M — Tolerance
M=±20%
S =+30%
−10%

016 — Voltage
016=16VDC
100=100VDC
6P3=6.3VDC

J — Mechanical Characteristics
J=Standard
*P=Solvent Resistant

M — Insulation
M=Standard PVC

B — Packaging (see Application Guidelines)
B=Standard Bulk
T=Tape and Reel
A=Ammo Pack

S — Lead Configuration
S=Standard
Options (see Application Guidelir
C=Cut
D=Forming Cut
F=Snap in Forming Cut
M=Snap in Cut

*See "Application Guidelines" section page 120 for approved solvents and cleaning solutions.

*May be ordered American National Standards Institute.

SERIES 3480

Miniature Single-Ended Aluminum Electrolytic Capacitors

DESCRIPTION:

Series 3480 capacitors are much smaller than conventional general-purpose miniature aluminum electrolytic capacitors. A newly developed, high-magnification etched foil is employed which allows the 3480 to be almost identical in case size to the 3476. A wide temperature range of −55 to +105°C and a long life of 1000 hours at 105°C is made possible by a newly developed, high-performance electrolyte and a special sealing material. Series 3480 employs the newest high-stability anode foil so that leakage current will change minimally even if the capacitors are left unused for a long period.

Series 3480 capacitors are useful in an extensive range of applications, both consumer and industrial. They are highly stable products suitable for time constant circuits.

FEATURES:

- Wide temperature range of (−55 to 105°C 6.3 to 100V; −40 to 105°C 160 to 250VDC.).
- Higher CV values compared to ordinary aluminum electrolytic capacitors.
- Load life of 1000 hours at 105°C with no voltage derating.
- Very low leakage current.
- Smaller size allows wider choice of capacitance and voltage for automatic insertion.
- Safety vents with the exception of 5mm diameter cans.
- Halogenated Solvent Proof Configuration available.

For Application Guidelines see pages 119-125

SERIES 3480

Miniature Single-Ended Aluminum Electrolytic Capacitors

1 **Aluminum Electric Capacitors**

CHARACTERISTICS

Item	Characteristic	
Voltage Range	6.3～100V·DC	160～250V·DC
Operating Temperature Range	−55～+105°C	−40～+105°C
Capacitance Tolerance	±20% (M) (at 20°C, 120Hz)	
Leakage Current	The following specifications shall be satisfied when the rated voltage is applied for the required time. After 2 minutes: 0.002CV (μA) or 0.2μA, whichever is greater	After 1 minute : 0.1CV + 40 (μA) (CV≦1000) 0.04CV + 100 (μA) (CV>1000) After 5 minutes : 0.03CV + 15 (μA) (CV≦1000) 0.02CV + 25 (μA) (CV>1000) Where, C: Nominal capacitance (μF), V: Rated voltage (V) (at 20°C)
Dissipation Factor (Tan δ)	See table below.	

Dissipation Factor (Tan δ):

Rated voltage (V)	6.3	10	16	25	35	50	63, 80	100	160	200	250
Tan δ	0.22	0.19	0.16	0.14	0.12	0.10	0.08	0.07	0.15	0.12	0.10

For capacitors whose rated voltage is 100V or less and whose capacitance exceeds 1,000μF, the specification of tan δ is increased by 0.02 for every addition of 1,000μF. (at 20°C, 120Hz)

Item	Characteristic	
Temperature Characteristics	(1) Capacitance change: Capacitance at −40°C is more than 80% of 20°C value.	(1) Capacitance change: Capacitance at −40°C is more than 70% of 20°C value.

(2) Impedance ratio at 120Hz

Rated voltage (V)	6.3	10	16	25	35	50	63	80	100	160	200	250
Z(−25°C)/Z(20°C)	3	2	2	2	2	2	2	2	2	3	3	3
Z(−40°C)/Z(20°C)	6	5	3	3	3	3	3	3	3	4	4	4

Item	Characteristic	
Load Life	The following specifications shall be satisfied when the capacitors are restored to 20°C after the rated voltage applied for 1,000 hours at 105°C. >10mm DIA 2.000 HRS PMBS TYPE Capacitance change from initial value (see table below) Dissipation factor ≦200% of initial specified value Leakage current ≦ initial specified value	The following specifications shall be satisfied when the capacitors are restored to 20°C after the rated voltage applied for 1,000 hours at 105°C. Capacitance change ≦±20% of initial value Dissipation factor ≦200% of initial specified value Leakage current ≦ initial specified value
Shelf Life	The following specifications shall be satisfied when the capacitors are restored to 20°C after exposing them at 105°C for 1,000 hours without voltage applied. Capacitance change value shall be within the specifications shown on the table of load life. Dissipation factor ≦200% of initial specified value Leakage current ≦200% of initial specified value	The following specifications shall be satisfied when the capacitors are restored to 20°C after exposing them at 105°C for 1,000 hours without voltage applied. Capacitance change ≦±20% of initial value Dissipation factor ≦200% of initial specified value Leakage current ≦500% of initial specified value
Others	Satisfies characteristic W of JIS C5141*—Test Methods per JIS 5102**	

Load life capacitance change from initial value:

6.3～16V	±25%
25～100V	±20%

*May be ordered American National Standards Institute.

**A summary of these standards appears on page 127.

Philips Components • 6071 St. Andrews Road • Columbia, SC 29212-3198 • (803) 772-2500 • FAX: (803) 772-2445

SERIES 3480

Miniature Single-Ended Aluminum Electrolytic Capacitors

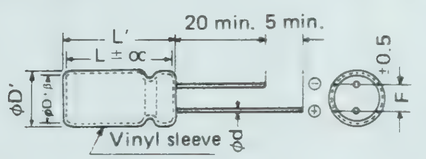
CASE SIZE OF STANDARD PRODUCTS

ΦD x L (mm)

µF \ V	6.3	10	16	25	35	50	63	80	100	160	200	250
0.47						5x11			5x11	6.3x11		
1						5x11			5x11	6.3x11		10x16
2.2						5x11			5x11	8x11.5		10x16
3.3						5x11			5x11	10x16	10x16	10x16
4.7						5x11	5x11	6.3x11	6.3x11	10x16	10x16	10x16
10						5x11	6.3x11	8x11.5	8x11.5	10x16	10x20	12.5x20
22				5x11	6.3x11	6.3x11	8x11.5	10x12.5	10x12.5	12.5x20	12.5x20	12.5x25
33			5x11	6.3x11	6.3x11	8x11.5	8x11.5	10x16	10x16	12.5x25	16x25	16x25
47		5x11	6.3x11	6.3x11	8x11.5	8x11.5	10x12.5	10x16	10x20	16x25	16x25	16x31.5
100		6.3x11	8x11.5	8x11.5	10x12.5	10x16	10x20	12.5x20	12.5x20	16x35.5	18x40	
220	8x11.5	8x11.5	10x12.5	10x16	10x20	12.5x20	12.5x20	12.5x25	16x25			
330	10x12.5	10x12.5	10x16	10x20	12.5x20	12.5x20	12.5x25	16x31.5	16x31.5			
470	10x12.5	10x16	10x20	12.5x20	12.5x25	16x25	16x25	16x35.5	18x35.5			
1000	10x20	12.5x20	12.5x25	16x25	16x25	16x31.5	18x35.5					
2200	12.5x25	16x25	16x25	16x35.5	18x35.5							
3300	16x25	16x31.5	16x35.5	18x40								
4700	16x31.5	16x35.5	18x35.5									
10000	18x40											

CASE OUTLINE DRAWING

Unit (mm)



D	φ5	φ6.3	φ8	φ10	φ12.5	φ16	φ18
L'	L+1.5					L+2.0	
D'	D+0.5					D+0.5	
d	0.5	0.6	0.6	0.6	0.6	0.8	0.8
F	2	2.5	3.5	5	5	7.5	7.5

For L≦10, α=1 For D≦10, β=0.5
For L>10, α=2 For D>10, β=1

See page 126 for mm to inches conversion table.

Note: With the exception of 5mm diameter cans, all 3480 capacitors have a safety vent.

SERIES 3480

Miniature Single-Ended Aluminum Electrolytic Capacitors

STANDARD CAPACITANCE VALUES

Capacitance µF	PHILIPS COMPONENTS Part Number	Case Code	Maximum ESR (OHMS) 120Hz, 25°C	Max. RMS Ripple Current AMPS at 120Hz, 105°C
6.3VDC WORKING, 8VDC SURGE				
220	3480FC221M6P3JMBS	FC	1.658	.155
330	3480GC331M6P3JMBS	GC	1.105	.222
470	3480GC471M6P3JMBS	GC	.776	.265
1000	3480GF102M6P3JMBS	GF	.365	.460
2200	3480HG222M6P3JMBS	HG	.181	.787
3300	3480KG332M6P3JMBS	KG	.115	1.027
4700	3480KJ472M6P3JMBS	KJ	.089	1.270
10000	3480LK103M6P3JMBS	LK	.061	2.037
10VDC WORKING, 13VDC SURGE				
47	3480CB470M010JMBS	CB	6.703	.060
100	3480DB101M010JMBS	DB	3.150	.099
220	3480FC221M010JMBS	FC	1.431	.170
330	3480GC331M010JMBS	GC	.955	.243
470	3480GD471M010JMBS	GD	.670	.317
1000	3480HF102M010JMBS	HF	.315	.560
2200	3480KG222M010JMBS	KG	.159	.946
3300	3480KJ332M010JMBS	KJ	.115	1.189
4700	3480KL472M010JMBS	KL	.089	1.410
16VDC WORKING, 20VDC SURGE				
33	3480CB330M016JMBS	CB	8.039	.056
47	3480DB470M016JMBS	DB	5.644	.076
100	3480FC101M016JMBS	FC	2.653	.128
220	3480GC221M016JMBS	GC	1.206	.222
330	3480GD331M016JMBS	GD	.804	.297
470	3480GF471M016JMBS	GF	.565	.386
1000	3480HG102M016JMBS	HG	.265	.676
2200	3480KG222M016JMBS	KG	.136	1.046
3300	3480KL332M016JMBS	KL	.100	1.582
4700	3480LL472M016JMBS	LL	.078	1.881
25VDC WORKING, 32VDC SURGE				
22	3480CB220M025JMBS	CB	10.550	.049
33	3480DB330M025JMBS	DB	7.034	.068
47	3480DB470M025JMBS	DB	4.939	.081
100	3480FC101M025JMBS	FC	2.321	.137
220	3480GD221M025JMBS	GD	1.055	.260
330	3480GF331M025JMBS	GF	.704	.346
470	3480HF471M025JMBS	HF	.494	.458
1000	3480KG102M025JMBS	KG	.233	.800
2200	3480KL222M025JMBS	KL	.120	1.230
3300	3480LK322M025JMBS	LK	.090	1.620
35VDC WORKING, 44VDC SURGE				
22	3480DB220M035JMBS	DB	9.043	.060
33	3480DB330M035JMBS	DB	6.029	.073
47	3480FC470M035JMBS	FC	4.233	.101
100	3480GC101M035JMBS	GC	1.990	.172
220	3480GF221M035JMBS	GF	.904	.305
330	3480HF331M035JMBS	HF	.603	.415
470	3480HG471M035JMBS	HG	.424	.535
1000	3480KG102M035JMBS	KG	.198	.864
2200	3480LL222M035JMBS	LL	.105	1.359

Capacitance µF	PHILIPS COMPONENTS Part Number	Case Code	Maximum ESR (OHMS) 120Hz, 25°C	Max. RMS Ripple Current AMPS at 120Hz, 105°C
50VDC WORKING, 63VDC SURGE				
.47	3480CB478M050JMBS	CB	352.738	.006
1	3480CB109M050JMBS	CB	165.786	.012
2.2	3480CB229M050JMBS	CB	75.358	.018
3.3	3480CB339M050JMBS	CB	50.239	.022
4.7	3480CB479M050JMBS	CB	35.274	.027
10	3480CB100M050JMBS	CB	16.579	.039
22	3480DB220M050JMBS	DB	7.536	.065
33	3480FC330M050JMBS	FC	5.024	.093
47	3480FC470M050JMBS	FC	3.528	.111
100	3480GD101M050JMBS	GD	1.658	.207
220	3480HF221M050JMBS	HF	.754	.371
330	3480HF331M050JMBS	HF	.503	.454
470	3480KG471M050JMBS	KG	.353	.649
1000	3480KJ102M050JMBS	KJ	.166	1.014
63VDC WORKING, 79VDC SURGE				
4.7	3480CB479M063JMBS	CB	28.219	.030
10	3480DB100M063JMBS	DB	13.263	.050
22	3480FC220M063JMBS	FC	6.029	.085
33	3480FC330M063JMBS	FC	4.019	.104
47	3480GC470M063JMBS	GC	2.823	.145
100	3480GF101M063JMBS	GF	1.326	.252
220	3480HF221M063JMBS	HF	.603	.414
330	3480HG331M063JMBS	HG	.403	.550
470	3480KG471M063JMBS	KG	.283	.725
1000	3480LL102M063JMBS	LL	.133	1.212
80VDC WORKING, 100VDC SURGE				
4.7	3480DB479M080JMBS	DB	28.219	.034
10	3480FC100M080JMBS	FC	13.263	.057
22	3480GC220M080JMBS	GC	6.029	.099
33	3480GD330M080JMBS	GD	4.019	.133
47	3480GD470M080JMBS	GD	2.823	.158
100	3480HF101M080JMBS	HF	1.326	.280
220	3480HG221M080JMBS	HG	.603	.449
330	3480KJ331M080JMBS	KJ	.403	.651
470	3480KL471M080JMBS	KL	.283	.804
100VDC WORKING, 125VDC SURGE				
0.47	3480CB478M100JMBS	CB	246.916	.010
1	3480CB109M100JMBS	CB	116.05	.015
2.2	3480CB229M100JMBS	CB	52.75	.022
3.3	3480CB339M100JMBS	CB	35.166	.027
4.7	3480DB479M100JMBS	DB	24.691	.036
10	3480FC100M100JMBS	FC	11.605	.061
22	3480GC220M100JMBS	GC	5.275	.106
33	3480GD330M100JMBS	GD	3.516	.142
47	3480GF470M100JMBS	GF	2.469	.184
100	3480HF101M100JMBS	HF	1.160	.298
220	3480KG221M100JMBS	KG	.528	.530
330	3480KJ331M100JMBS	KJ	.351	.699
470	3480LL471M100JMBS	LL	.248	.888

SERIES 3480

Miniature Single-Ended Aluminum Electrolytic Capacitors

STANDARD CAPACITANCE VALUES

Capacitance µF	Philips Components Part Number	Case Code	Maximum ESR (OHMS) 120Hz, 25°C	Max. RMS Ripple Current AMPS at 120Hz, 85°C
160VDC WORKING, 200VDC SURGE				
0.47	3480DB478M160JMBS	DB	529.11	.007
1	3480DB109M160JMBS	DB	248.68	.011
2.2	3480FC229M160JMBS	FC	113.04	.019
3.3	3480GD339M160JMBS	GD	75.36	.030
4.7	3480GD479M160JMBS	GD	52.91	.036
10	3480GD100M160JMBS	GD	24.87	.053
22	3480HF220M160JMBS	HF	11.30	.095
33	3480HG330M160JMBS	HG	7.54	.127
47	3480KG470M160JMBS	KG	5.29	.168
100	3480KL101M160JMBS	KL	2.49	.270
200VDC WORKING, 250VDC SURGE				
3.3	3480GD339M200JMBS	GD	60.29	.034
4.7	3480GD479M200JMBS	GD	42.33	.041
10	3480GF100M200JMBS	GF	19.89	.065
22	3480HF220M200JMBS	HF	9.04	.107
33	3480KG330M200JMBS	KG	6.03	.157
47	3480KG470M200JMBS	KG	4.23	.188
100	3480LK101M200JMBS	LK	1.99	.320

Capacitance µF	Philips Components Part Number	Case Code	Maximum ESR (OHMS) 120Hz, 25°C	Max. RMS Ripple Current AMPS at 120Hz, 85°C
250VDC WORKING, 300VDC SURGE				
1	3480GD109M250JMBS	GD	165.79	.020
2.2	3480GD229M250JMBS	GD	75.36	.030
3.3	3480GD339M250JMBS	GD	50.24	.037
4.7	3480GD479M250JMBS	GD	35.27	.045
10	3480HF100M250JMBS	HF	16.58	.079
22	3480HG220M250JMBS	HG	7.54	.127
33	3480KG330M250JMBS	KG	5.02	.172
47	3480KJ470M250JMBS	KJ	3.53	.221

CASE DIMENSIONS

Case Code	Diameter (mm)	Length (mm)
CB	5	11
DB	6.3	11
FC	8	11.5
GC	10	12.5
GD	10	16
GF	10	20
HF	12.5	20

Case Code	Diameter (mm)	Length (mm)
HG	12.5	25
KG	16	25
KJ	16	31.5
KL	16	35.5
LL	18	35.5
LK	18	40

HOW TO SPECIFY

Series 3480 Capacitors can be completely specified using the following designation:

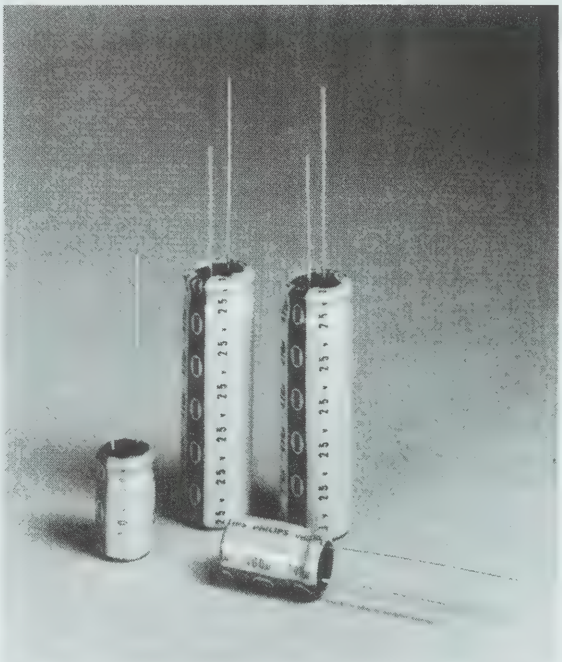
3480 GF 471 M 016 J M B S

- **3480** — **Philips Components Product Series**
- **GF** — **Case Size Code** (see physical spec)
- **471** — **Capacitance**
  XX=Significant Digits
  X=Multiplier
  i.e. 471=470µF
  470= 47µF
  478=.47µF
- **M** — **Tolerance**
  M=±20%
- **016** — **Voltage**
  016=16VDC
  100=100VDC
  6P3=6.3VDC
- **J** — **Mechanical Characteristics**
  J=Standard
  P=Solvent Resistant*
- **M** — **Insulation**
  M=Standard PVC
- **B** — **Packaging**
  B=Standard Bulk
  T=Tape and Reel
- **S** — **Lead Configuration**
  S=Standard
  Options (see Application Guidelines)
  C=Cut
  D=Forming Cut
  F=Snap in Forming Cut
  M=Snap in Cut
  H=Cut–6.35mm

*See "Application Guidelines" section page 120 for approved solvents and cleaning solutions.

SERIES 3481

Miniature Single-Ended Aluminum Electrolytic Capacitors



DESCRIPTION:

Series 3481 capacitors exhibit long operating life (2000 hours at 105°C) and very low impedance and ESR. They have a higher ripple current rating than general purpose aluminum electrolytic capacitors and are suitable for use in switching power supplies.

FEATURES:

- Very low impedance and ESR.
- High permissible ripple current.
- Wide operating temperature range (−55 to +105°C).
- Long life and high reliability equivalent to 2000 hours at 105°C.
- Halogenated Solvent Proof Configuration available.

For Application Guidelines see pages 119-125

SERIES 3481
Miniature Single-Ended Aluminum Electrolytic Capacitors

CHARACTERISTICS

<table>
<tr><th>Item</th><th>Characteristic</th></tr>
<tr><td>Operating Temperature Range</td><td>−55 ~ +105°C</td></tr>
<tr><td>Capacitance Tolerance</td><td>−10 ~ +100% (at 120Hz, 20°C)</td></tr>
<tr><td>Equivalent Series Resistance (ESR)</td><td>When measured at a temperature of 20°C and a frequency of 120 and 1000Hz, the ESR shall not exceed the specified values given in the tables on page</td></tr>
<tr><td>Impedence</td><td>When measured at a temperature of 20°C and frequency of 100KHz, the impedance shall to exceed the specified values given in the table.</td></tr>
<tr><td>Equivalent Series Inductance</td><td>When measured at a frequency of 1MHz and within 3mm of the body of the capacitor, the ESL shall not exceed 20nH.</td></tr>
<tr><td>Leakage Current</td><td>0.002CV (μA) or 2μA, whichever is greater. (After 3 minutes)
where C: Nominal capacitance (μF)
V: Rated working voltage (V) (at 20°C)</td></tr>
<tr><td>Low Temperature Characteristics</td><td>Capacitance at −55°C shall not be less than 70% of the initial 20°C measured value and the ratio of impedance at 120Hz shall not exceed the following values.
<table>
<tr><td>Rated voltage (V)</td><td>10</td><td>16</td><td>25</td><td>35</td><td>50</td><td>63</td><td>100</td></tr>
<tr><td>Z−55°C/Z20°C</td><td>4</td><td>3</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
</table></td></tr>
<tr><td>Surge Voltage</td><td>
<table>
<tr><td>Rated voltage (V)</td><td>10</td><td>16</td><td>25</td><td>35</td><td>50</td><td>63</td><td>100</td></tr>
<tr><td>Surge Voltage</td><td>13</td><td>20</td><td>32</td><td>44</td><td>63</td><td>79</td><td>125</td></tr>
</table></td></tr>
<tr><td>Load Life</td><td>The following specifications shall be satisfied when the capacitors are restored to 20°C after the rated voltage applied for 2,000 hours at 105°C.
Capacitance change ≦ ±15% of initial value
ESR at 120Hz and 1KHz ≦150% of initial specified value
Leakage current ≦ initial specified value</td></tr>
<tr><td>Shelf Life</td><td>The following specifications shall be satisfied when the capacitors are restored to 20°C after exposing them at 105°C for 500 hours without voltage applied.
Capacitance change ≦ ±10% of initial value
ESR at 120Hz and 1KHz ≦150% of initial specified value
Leakage current ≦ 200% of initial specified value</td></tr>
<tr><td>Permissible Ripple Current</td><td>Refer to tables on page . When the ambient temperature and frequency are different from 85°C and 100KHz respectively, the ripple current shall not exceed the value multiplied by the factor given in Fig. 1 and Fig. 2, page 80.</td></tr>
<tr><td>Others</td><td>Satisfies characteristics C of JIS C5141*—Test Methods per JIS 5102**</td></tr>
</table>

*May be ordered American National Standards Institute.

**A summary of these standards appears on page 127.

STANDARD CAPACITANCE VALUES

10VDC WORKING, 13VDC SURGE

Capacitance μF	Philips Components Part Number	Case Code	ESR (Ω) at 20°C 120Hz	ESR (Ω) at 20°C 1KHz	Max. Ripple Current (A RMS) at 85°C & 100KHz
47	3481AA470V010JDBS	AA	3.5	1.9	0.26
100	3481BC101V010JDBS	BC	1.8	1.0	0.33
220	3481BD221V010JDBS	BD	1.0	0.58	0.48
330	3481CD331V010JDBS	CD	0.48	0.28	0.73
470	3481CE471V010JDBS	CE	0.24	0.16	1.42
1000	3481CF102V010JDBS	CF	0.12	0.076	2.87

16VDC WORKING, 20VDC SURGE

Capacitance μF	Philips Components Part Number	Case Code	ESR (Ω) at 20°C 120Hz	ESR (Ω) at 20°C 1KHz	Max. Ripple Current (A RMS) at 85°C & 100KHz
33	3481AA330V016JDBS	AA	4.0	2.0	0.19
47	3481BB470V016JDBS	BB	2.8	1.4	0.26
100	3481BC101V016JDBS	BC	1.5	0.8	0.45
220	3481CD221V016JDBS	CD	0.61	0.35	0.71
330	3481CE331V016JDBS	CE	0.28	0.17	1.31
680	3481CF681V016JDBS	CF	0.14	0.09	2.44

SERIES 3481

Miniature Single-Ended Aluminum Electrolytic Capacitors

STANDARD CAPACITANCE VALUES

Capacitance µF	Philips Components Part Number	Case Code	ESR (Ω) at 20°C 120Hz	ESR (Ω) at 20°C 1KHz	Max. Ripple Current (A RMS) at 85°C & 100KHz
25VDC WORKING, 32VDC SURGE					
22	3481AA220V025JDBS	AA	5.0	2.0	0.15
33	3481BB330V025JDBS	BB	2.8	1.7	0.24
68	3481BC680V025JDBS	BC	1.5	0.85	0.40
100	3481BD101V025JDBS	BD	1.2	0.60	0.47
220	3481CE221V025JDBS	CE	0.40	0.27	1.02
470	3481CF471V025JDBS	CF	0.16	0.10	1.90
35VDC WORKING, 44VDC SURGE					
10	3481AA100V035JDBS	AA	7.0	2.0	0.13
22	3481BB220V035JDBS	BB	2.5	1.5	0.26
47	3481BC470V035JDBS	BC	2.2	1.0	0.31
68	3481BD680V035JDBS	BD	1.3	0.80	0.45
100	3481CE101V035JDBS	CE	0.80	0.40	1.00
330	3481CF331V035JDBS	CF	0.26	0.20	1.55
50VDC WORKING, 63VDC SURGE					
10	3481AA100V050JDBS	AA	10.0	4.5	0.10
33	3481BC330V050JDBS	BC	2.3	1.8	0.26
47	3481BD470V050JDBS	BD	2.0	1.0	0.34
100	3481CE101V050JDBS	CE	0.76	0.42	0.69
220	3481CF221V050JDBS	CF	0.40	0.25	1.28

Capacitance µF	Philips Components Part Number	Case Code	ESR (Ω) at 20°C 120Hz	ESR (Ω) at 20°C 1KHz	Max. Ripple Current (A RMS) at 85°C & 100KHz
63VDC WORKING, 79VDC SURGE					
6.8	3481AA689V063JDBS	AA	18.0	8.0	0.075
10	3481BB100V063JDBS	BB	10.0	5.0	0.10
22	3481BC220V063JDBS	BC	4.0	2.8	0.19
33	3481BD330V063JDBS	BD	3.5	2.0	0.24
68	3481CE680V063JDBS	CE	1.2	0.60	0.55
100	3481CF101V063JDBS	CF	0.60	0.30	1.18
100VDC WORKING, 125VDC SURGE					
2.2	3481AA229V100JDBS	AA	70.0	30.0	0.075
3.3	3481BB339V100JDBS	BB	48.3	20.0	0.081
6.8	3481BC689V100JDBS	BC	20.0	4.5	0.12
10	3481BD100V100JDBS	BD	13.3	3.0	0.17
22	3481CE220V100JDBS	CE	2.0	0.80	0.60
47	3481CF470V100JDBS	CF	0.88	0.35	1.10

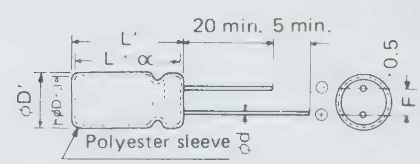
CASE SIZE OF STANDARD PRODUCTS

D x L (mm)

µF \ V	10	16	25	35	50	63	100
2.2							8x11.5
3.3							10x12.5
6.8						8x11.5	10x16.5
10				8x11.5	8x11.5	10x12.5	10x20.5
22			8x11.5	10x12.5		10x16.5	12.5x24.5
33.		8x11.5	10x12.5		10x16.5	10x20.5	
47	8x11.5	10x12.5		10x16.5	10x20.5		12.5x42.5
68			10x16.5	10x20.5		12.5x24.5	
100	10x16.5	10x16.5	10x20.5	12.5x24.5	12.5x24.5	12.5x42.5	
220	10x20.5	12.5x20.5	12.5x24.5		12.5x42.5		
330	12.5x20.5	12.5x24.5		12.5x42.5			
470	12.5x24.5		12.5x42.5				
680		12.5x42.5					
1000	12.5x42.5						

CASE OUTLINE DRAWING

Unit (mm)



For L≦10, ∝=1 For D≦10, β=0.5
For L>10, ∝=2 For D>10, β=1

D	D'	L'	F	d
8	D+0.5	L+2.0	3.5	0.6
10	D+1.0	L+2.0	5.0	0.6
12.5	D+1.0	L+2.0	5.0	0.6

See page 126 for mm to inches conversion table.
Note: All 3481 capacitors have a safety vent.

RIPPLE CURRENT MULTIPLIERS

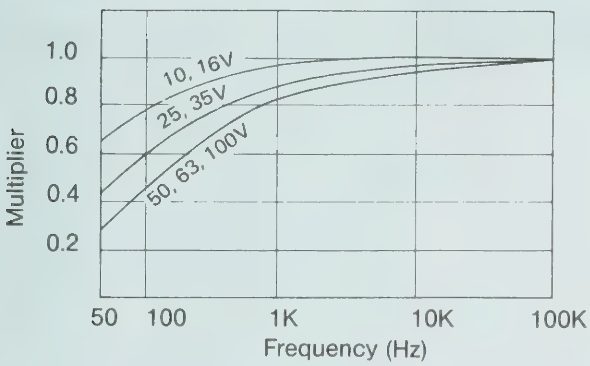


Fig. 1

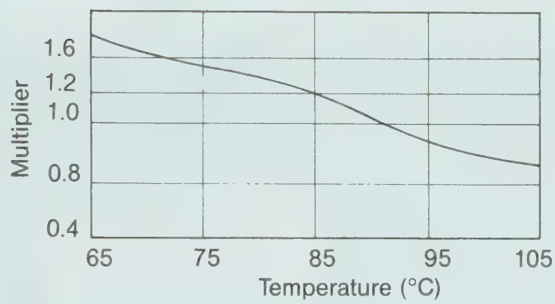


Fig. 2

CASE DIMENSIONS

Case Code	Diameter (mm)	Length (mm)
AA	8	11.5
BB	10	12.5
BC	10	16.5
BD	10	20.5
CD	12.5	20.5
CE	12.5	24.5
CF	12.5	42.5

HOW TO SPECIFY

Philips Components Series 3481 Capacitors can be completely specified using the following designation:

3481 CE 471 V 010 J D B S

Philips Components Product Series — 3481

Case Size Code (see physical spec) — CE

Capacitance — 471
XX=Significant Digits
X=Multiplier
i.e. 471=470μF
470= 47μF
478=.47μF

Tolerance — V
V=−10+100%

Voltage — 010
016=16VDC
100=100VDC
6P3=6.3VDC

Mechanical Characteristics — J
J=Standard
P=Solvent Resistant

Insulation — D
D=Polyester

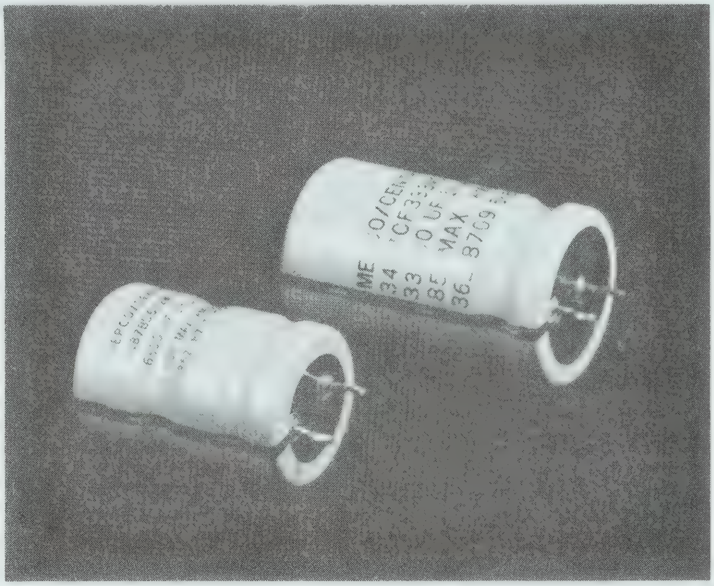
Packaging — B
B=Standard Bulk
T=Tape and Reel
A=Ammo Pack

Lead Configuration — S
S=Standard
Options (see Application Guidelines)
C=Cut
D=Forming Cut
F=Snap in Forming Cut
M=Snap in Cut

*See "Application Guidelines" section page 120 for approved solvents and cleaning conditions.

SUPER SNAP™ SERIES 3487

Industrial/ Computer Grade Snap-In Aluminum Electrolytic Capacitors



DESCRIPTION:

The Series 3487 utilizes a new snap-in terminal configuration. This allows fast and easy mounting onto printed circuit boards, eliminating the need for mounting hardware and reducing assembly time.

State of the art etching and anodizing processes have resulted in CV products that are equivalent to, or better than, those of most presently available aluminum electrolytic capacitors (110,000 μF at 6.3 WVDC in a 35 x 80 mm case).

A newly designed safety vent is integrated into the top of the case, opposite from the terminal end. The possibility of printed circuit board spoilage is thereby reduced.

A plastic coating of the terminal header is available and provides excellent resistance to the entrance of most normally used printed circuit board cleaners.

All connections of the 3487 are welded to insure long-term electrical integrity.

FEATURES:

ELECTRICAL

- Extremely high CV density.
- Capacitance from 68 to 110,000 μF.
- Voltage range from 6.3 WVDC to 450 WVDC.
- 85°C ambient operating temperature.
- 2,000-hour life at 85°C with rated DC voltage applied.
- Standard capacitance tolerance ±20%.
- Excellent frequency response.

MECHANICAL

- Snap-in (self-mounting) terminals
- All welded construction
- Venting mechanism at the top of the case for better printed circuit board protection.
- Pitchless construction (no potting compound).
- Protective plastic end seal to allow on-board cleaning (upon request).
- Integral stand off feet on terminal cover for ease of board cleaning.

For Application Guidelines see pages 119-125

SUPER SNAP™ SERIES 3487

6.3 VDC WORKING, 8 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
15000	3487BD153M6P3DF	25*35	.048	3.44
18000	3487BE183M6P3DF	25*40	.039	4.01
27000	3487BF273M6P3DF	25*50	.029	5.08
18000	3487CC183M6P3DF	30*30	.074	2.97
22000	3487CD223M6P3DF	30*35	.056	3.61
27000	3487CE273M6P3DF	30*40	.045	4.20
39000	3487CF393M6P3DF	30*50	.033	5.30
56000	3487CG563M6P3FF	30*63	.025	6.75
80000	3487CH803M6P3FF	30*80	.02	8.33
27000	3487DC273M6P3DF	35*30	.088	3.02
33000	3487DD333M6P3DF	35*35	.067	3.64
39000	3487DE393M6P3DF	35*40	.054	4.24
56000	3487DF563M6P3DF	35*50	.04	5.36
81000	3487DG813M6P3FF	35*63	.029	6.84
110000	3487DH114M6P3FF	35*80	.023	8.46

10 VDC WORKING, 13 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
12000	3487BD123M010DF	25*35	.048	3.43
15000	3487BE153M010DF	25*40	.039	4.00
22000	3487BF223M010DF	25*50	.029	5.07
15000	3487CC153M010DF	30*30	.074	2.97
18000	3487CD183M010DF	30*35	.056	3.60
22000	3487CE223M010DF	30*40	.045	4.19
33000	3487CF333M010DF	30*50	.033	5.29
39000	3487CG393M010FF	30*63	.024	6.77
56000	3487CH563M010FF	30*80	.019	8.35
22000	3487DC223M010DF	35*30	.089	3.00
27000	3487DD273M010DF	35*35	.067	3.63
33000	3487DE333M010DF	35*40	.055	4.22
47000	3487DF473M010DF	35*50	.040	5.33
56000	3487DG563M010FF	35*63	.029	6.83
82000	3487DH823M010FF	35*80	.023	8.42

16 VDC WORKING, 20 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
10000	3487BD103M016DF	25*35	.049	3.42
12000	3487BE123M016DF	25*40	.040	3.99
18000	3487BF183M016DF	25*50	.029	5.06
10000	3487CC103M016DF	30*30	.073	2.98
15000	3487CD153M016DF	30*35	.056	3.59
18000	3487CE183M016DF	30*40	.045	4.18
22000	3487CF223M016DF	30*50	.033	5.30
33000	3487CG333M016FF	30*63	.025	6.75
47000	3487CH473M016FF	30*80	.02	8.33
15000	3487DC153M016DF	35*30	.090	2.99
22000	3487DD223M016DF	35*35	.068	3.60
27000	3487DE273M016DF	35*40	.055	4.19
39000	3487DF393M016DF	35*50	.041	5.29
47000	3487DG473M016FF	35*63	.029	6.78
68000	3487DH683M016FF	35*80	.023	8.37

25 VDC WORKING, 32 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
6800	3487BD682M025DF	25*35	.050	3.39
8200	3487BE822M025DF	25*40	.040	3.95
12000	3487BF123M025DF	25*50	.030	5.01
6800	3487CC682M025DF	30*30	.074	2.97
10000	3487CD103M025DF	30*35	.056	3.59
12000	3487CE123M025DF	30*40	.045	4.18
18000	3487CF183M025DF	30*50	.033	5.29
22000	3487CG223M025FF	30*63	.025	6.73
33000	3487CH333M025FF	30*80	.02	8.33
10000	3487DC103M025DF	35*30	.089	3.00
15000	3487DD153M025DF	35*35	.068	3.61
18000	3487DE183M025DF	35*40	.055	4.19
22000	3487DF223M025DF	35*50	.040	5.31
33000	3487DG333M025FF	35*63	.029	6.78
47000	3487DH473M025FF	35*80	.023	8.39

35 VDC WORKING, 44 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
4700	3487BD472M035DF	25*35	.051	3.34
6800	3487BE682M035DF	25*40	.041	3.92
8200	3487BF822M035DF	25*50	.031	4.94
5600	3487CC562M035DF	30*30	.074	2.97
6800	3487CD682M035DF	30*35	.057	3.57
10000	3487CE103M035DF	30*40	.046	4.17
12000	3487CF123M035DF	30*50	.034	5.26
18000	3487CG183M035FF	30*63	.025	6.72
22000	3487CH223M035FF	30*80	.020	8.28
8200	3487DC822M035DF	35*30	.090	2.99
10000	3487DD103M035DF	35*35	.068	3.61
12000	3487DE123M035DF	35*40	.055	4.19
18000	3487DF183M035DF	35*50	.040	5.30
22000	3487DG223M035FF	35*63	.029	6.77
33000	3487DH333M035FF	35*80	.023	8.39

50 VDC WORKING, 63 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
3300	3487BD332M050DF	25*35	.053	3.27
3900	3487BE392M050DF	25*40	.044	3.80
5600	3487BF562M050DF	25*50	.032	4.84
3300	3487CC332M050DF	30*30	.077	2.92
4700	3487CD472M050DF	30*35	.058	3.54
5600	3487CE562M050DF	30*40	.047	4.11
8200	3487CF822M050DF	30*50	.035	5.20
10000	3487CG103M050FF	30*63	.026	6.59
15000	3487CH153M050FF	30*80	.020	8.20
4700	3487DC472M050DF	35*30	.091	2.98
6800	3487DD682M050DF	35*35	.068	3.60
8200	3487DE822M050DF	35*40	.055	4.18
12000	3487DF123M050DF	35*50	.041	5.29
15000	3487DG153M050FF	35*63	.030	6.73
22000	3487DH223M050FF	35*80	.023	8.35

SUPER SNAP™ SERIES 3487

300 VDC WORKING, 350 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
100	3487BD101M300DF	25*35	1.21	.689
120	3487BE121M300DF	25*40	1.01	.794
180	3487BF181M300DF	25*50	.678	1.05
120	3487CC121M300DF	30*30	1.04	.793
150	3487CD151M300DF	30*35	.831	.937
180	3487CE181M300DF	30*40	.691	1.07
270	3487CF271M300DF	30*50	.465	1.42
330	3487CG331M300FF	30*63	.377	1.73
470	3487CH471M300FF	30*80	.268	2.27
180	3487DC181M300DF	35*30	.736	1.04
220	3487DD221M300DF	35*35	.594	1.22
270	3487DE271M300DF	35*40	.484	1.42
390	3487DF391M300DF	35*50	.338	1.84
470	3487DG471M300FF	35*63	.275	2.23
680	3487DH681M300FF	35*80	.194	2.92

350 VDC WORKING, 400 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
100	3487BD101M350DF	25*35	1.05	.741
120	3487BE121M350DF	25*40	.876	.854
150	3487BF151M350DF	25*50	.698	1.04
100	3487CC101M350DF	30*30	1.07	.781
150	3487CD151M350DF	30*35	.727	1.00
180	3487CE181M350DF	30*40	.604	1.15
270	3487CF271M350DF	30*50	.408	1.52
330	3487CG331M350FF	30*63	.329	1.85
470	3487CH471M350FF	30*80	.235	2.42
150	3487DC151M350DF	35*30	.760	1.03
220	3487DD221M350DF	35*35	.531	1.29
270	3487DE271M350DF	35*40	.432	1.50
330	3487DF331M350DF	35*50	.345	1.82
470	3487DG471M350FF	35*63	.244	2.37
680	3487DH681M350FF	35*80	.173	3.09

400 VDC WORKING, 450 VDC SURGE

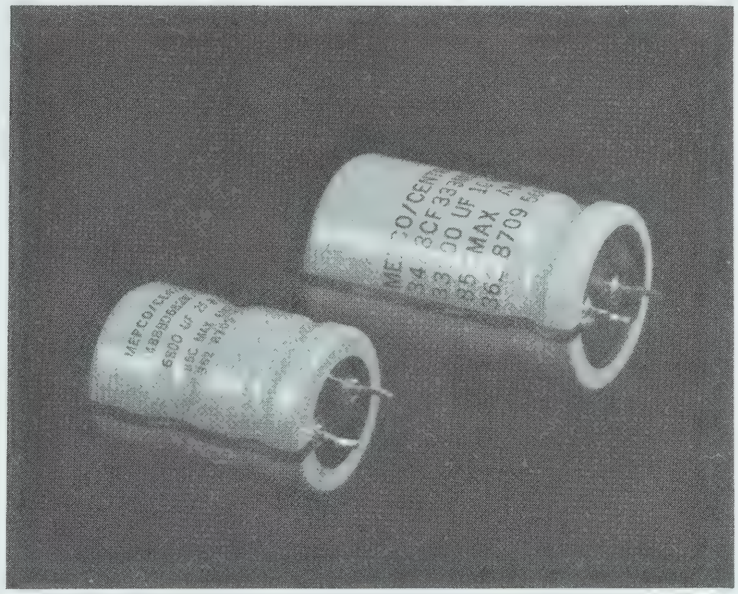
CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
82	3487BD820M400DF	25*35	1.16	.704
100	3487BE101M400DF	25*40	.953	.818
150	3487BF151M400DF	25*50	.639	1.09
100	3487CC101M400DF	30*30	.991	.814
120	3487CD121M400DF	30*35	.818	.944
150	3487CE151M400DF	30*40	.655	1.10
220	3487CF221M400DF	30*50	.451	1.45
270	3487CG271M400FF	30*63	.363	1.76
390	3487CH391M400FF	30*80	.255	2.32
120	3487DC121M400DF	35*30	.849	.976
180	3487DD181M400DF	35*35	.580	1.24
220	3487DE221M400DF	35*40	.473	1.43
330	3487DF331M400DF	35*50	.322	1.88
390	3487DG391M400FF	35*63	.264	2.27
560	3487DH561M400FF	35*80	.188	2.96

450 VDC WORKING, 500 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
68	3487BD680M450DF	25*35	1.32	.659
82	3487BE820M450DF	25*40	1.10	.761
120	3487BF121M450DF	25*50	.755	1.00
82	3487CC820M450DF	30*30	1.13	.761
100	3487CD101M450DF	30*35	.924	.888
120	3487CE121M450DF	30*40	.768	1.02
180	3487CF181M450DF	30*50	.517	1.35
220	3487CG221M450FF	30*63	.42	1.64
330	3487CH331M450FF	30*80	.284	2.20
120	3487DC121M450DF	35*30	.818	.994
150	3487DD151M450DF	35*35	.648	1.17
180	3487DE181M450DF	35*40	.537	1.35
270	3487DF271M450DF	35*50	.364	1.77
330	3487DG331M450FF	35*63	.292	2.16
470	3487DH471M450FF	35*80	.209	2.81

SUPER SNAP™ SERIES 3488

Industrial/ Computer Grade Snap-In Aluminum Electrolytic Capacitors



DESCRIPTION:

The Series 3488 utilizes a new snap-in terminal configuration. This allows fast and easy mounting onto printed circuit boards, eliminating the need for mounting hardware and reducing assembly time.

A newly designed safety vent is integrated into the top of the case, opposite from the terminal end. The possibility of printed circuit board spoilage is thereby reduced.

A plastic coating of the terminal header is available and provides excellent resistance to the entrance of most normally used printed circuit board cleaners.

All connections of the 3488 are welded to insure long-term electrical integrity.

FEATURES:

ELECTRICAL

- Capacitance from 150 to 56,000 μF.
- Voltage range from 6.3 WVDC to 250 WVDC.
- 85°C ambient operating temperature.
- 2,000-hour life at 105°C with rated DC voltage applied.
- Standard capacitance tolerance ±20%.
- Excellent frequency response.

MECHANICAL

- Snap-in (self-mounting) terminals
- All welded construction
- Venting mechanism at the top of the case for better printed circuit board protection.
- Pitchless construction (no potting compound).
- Protective plastic end seal to allow on-board cleaning (upon request).
- Integral stand off feet on terminal cover for ease of board cleaning.

SUPER SNAP™ SERIES 3488

6.3 VDC WORKING, 9 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
15000	3488BD153M6P3DF	25*35	.048	4.87
22000	3488BE223M6P3DF	25*40	.039	5.66
27000	3488BF273M6P3DF	25*50	.029	7.19
18000	3488CC183M6P3DF	30*30	.031	6.48
22000	3488CD223M6P3DF	30*35	.024	7.73
27000	3488CE273M6P3DF	30*40	.02	8.96
39000	3488CF393M6P3DF	30*50	.014	11.3
27000	3488DC273M6P3DF	35*30	.032	7.03
33000	3488DD333M6P3DF	35*35	.024	8.47
39000	3488DE393M6P3DF	35*40	.020	9.82
56000	3488DF563M6P3DF	35*50	.015	12.3

25 VDC WORKING, 40 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
5600	3488BD562M025DF	25*35	.050	4.77
8200	3488BE822M025DF	25*40	.040	5.59
10000	3488BF103M025DF	25*50	.030	7.06
6800	3488CC682M025DF	30*30	.034	6.20
8200	3488CD822M025DF	30*35	.026	7.36
12000	3488CE123M025DF	30*40	.020	8.76
15000	3488CF153M025DF	30*50	.016	10.8
10000	3488DC103M025DF	35*30	.033	6.96
12000	3488DD123M025DF	35*35	.025	8.34
15000	3488DE153M025DF	35*40	.021	9.66
22000	3488DF223M025DF	35*50	.015	12.1

10 VDC WORKING, 15 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
12000	3488BD123M010DF	25*35	.049	4.85
15000	3488BE153M010DF	25*40	.039	5.65
22000	3488BF223M010DF	25*50	.029	7.18
12000	3488CC123M010DF	30*30	.033	6.29
18000	3488CD183M010DF	30*35	.024	7.72
22000	3488CE223M010DF	30*40	.020	8.94
33000	3488CF333M010DF	30*50	.014	11.3
22000	3488DC223M010DF	35*30	.032	7.02
27000	3488DD273M010DF	35*35	.025	8.46
33000	3488DE333M010DF	35*40	.020	9.80
47000	3488DF473M010DF	35*50	.015	12.3

35 VDC WORKING, 50 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
4700	3488BD472M035DF	25*35	.051	4.73
5600	3488BE562M035DF	25*40	.042	5.50
8200	3488BF822M035DF	25*50	.031	7.00
5600	3488CC562M035DF	30*30	.034	6.17
6800	3488CD682M035DF	30*35	.027	7.34
8200	3488CE822M035DF	30*40	.022	8.48
12000	3488CF123M035DF	30*50	.016	10.7
6800	3488DC682M035DF	35*30	.034	6.85
10000	3488DD103M035DF	35*35	.026	8.28
12000	3488DE123M035DF	35*40	.021	9.59
18000	3488DF183M035DF	35*50	.015	12.1

16 VDC WORKING, 20 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
10000	3488BD103M016DF	25*35	.049	4.84
12000	3488BE123M016DF	25*40	.040	5.64
18000	3488BF183M016DF	25*50	.029	7.16
10000	3488CC103M016DF	30*30	.033	6.31
15000	3488CD153M016DF	30*35	.024	7.72
18000	3488CE183M016DF	30*40	.020	8.94
22000	3488CF223M016DF	30*50	.015	11.0
15000	3488DC153M016DF	35*30	.032	7.01
22000	3488DD223M016DF	35*35	.025	8.44
27000	3488DE273M016DF	35*40	.020	9.80
33000	3488DF333M016DF	35*50	.015	12.3

50 VDC WORKING, 75 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
2700	3488BD272M050DF	25*35	.055	4.57
3300	3488BE332M050DF	25*40	.045	5.31
4700	3488BF472M050DF	25*50	.033	6.76
2700	3488CC272M050DF	30*30	.040	5.69
3900	3488CD392M050DF	30*35	.029	7.00
4700	3488CE472M050DF	30*40	.024	8.08
6800	3488CF682M050DF	30*50	.017	10.3
3900	3488DC392M050DF	35*30	.037	6.59
5600	3488DD562M050DF	35*35	.027	8.00
6800	3488DE682M050DF	35*40	.022	9.27
10000	3488DF103M050DF	35*50	.016	11.7

63 VDC WORKING, 90 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
1800	3488BD182M063DF	25*35	.060	4.37
2200	3488BE222M063DF	25*40	.049	5.09
3300	3488BF332M063DF	25*50	.035	6.53
2200	3488CC222M063DF	30*30	.042	5.58
2700	3488CD272M063DF	30*35	.033	6.61
3300	3488CE332M063DF	30*40	.027	7.65
4700	3488CF472M063DF	30*50	.019	9.76
2700	3488DC272M063DF	35*30	.040	6.34
3900	3488DD392M063DF	35*35	.03	7.72
4700	3488DE472M063DF	35*40	.024	8.92
6800	3488DF682M063DF	35*50	.018	11.3

80 VDC WORKING, 100 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
1200	3488BD122M080DF	25*35	.170	2.60
1500	3488BE152M080DF	25*40	.137	3.04
2200	3488BF222M080DF	25*50	.097	3.95
1200	3488CC122M080DF	30*30	.150	2.95
1800	3488CD182M080DF	30*35	.103	3.75
2200	3488CE222M080DF	30*40	.084	4.35
3300	3488CF332M080DF	30*50	.058	5.69
1800	3488DC182M080DF	35*30	.113	3.78
2700	3488DD272M080DF	35*35	.080	4.72
3300	3488DE332M080DF	35*40	.065	5.47
4700	3488DF472M080DF	35*50	.047	6.98

100 VDC WORKING, 150 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
820	3488BD821M100DF	25*35	.185	2.49
1000	3488BE102M100DF	25*40	.151	2.90
1200	3488BF122M100DF	25*50	.121	3.54
820	3488CC821M100DF	30*30	.163	2.83
1200	3488CD122M100DF	30*35	.114	3.56
1500	3488CE152M100DF	30*40	.092	4.17
2200	3488CF222M100DF	30*50	.064	5.42
1200	3488DC122M100DF	35*30	.124	3.60
1800	3488DD182M100DF	35*35	.088	4.50
2200	3488DE222M100DF	35*40	.071	5.22
2700	3488DF272M100DF	35*50	.056	6.39

160 VDC WORKING, 200 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
270	3488BD271M160DF	25*35	.325	1.88
390	3488BE391M160DF	25*40	.234	2.33
560	3488BF561M160DF	25*50	.166	3.02
330	3488CC331M160DF	30*30	.256	2.26
470	3488CD471M160DF	30*35	.182	2.82
560	3488CE561M160DF	30*40	.152	3.24
680	3488CF681M160DF	30*50	.124	3.91
470	3488DC471M160DF	35*30	.193	2.89
560	3488DD561M160DF	35*35	.158	3.36
820	3488DE821M160DF	35*40	.113	4.15
1000	3488DF102M160DF	35*50	.090	5.04

200 VDC WORKING, 250 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
270	3488BD271M200DF	25*35	.344	1.83
390	3488BE391M200DF	25*40	.247	2.27
470	3488BF471M200DF	25*50	.200	2.75
330	3488CC331M200DF	30*30	.272	2.19
470	3488CD471M200DF	30*35	.193	2.74
560	3488CE561M200DF	30*40	.161	3.15
680	3488CF681M200DF	30*50	.131	3.79
470	3488DC471M200DF	35*30	.203	2.81
560	3488DD561M200DF	35*35	.167	3.26
820	3488DE821M200DF	35*40	.119	4.05
1000	3488DF102M200DF	35*50	.095	4.90

250 VDC WORKING, 300 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
150	3488BD151M250DF	25*35	.411	1.67
180	3488BE181M250DF	25*40	.341	1.93
270	3488BF271M250DF	25*50	.232	2.56
180	3488CC181M250DF	30*30	.331	1.99
220	3488CD221M250DF	30*35	.269	2.32
270	3488CE271M250DF	30*40	.219	2.70
390	3488CF391M250DF	30*50	.153	3.51
220	3488DC221M250DF	35*30	.278	2.40
330	3488DD331M250DF	35*35	.190	3.06
390	3488DE391M250DF	35*40	.160	3.49
560	3488DF561M250DF	35*50	.113	4.51

SUPER SNAP™ SERIES 3487

63 VDC WORKING, 79 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
2200	3487BD222M063DF	25*35	.057	3.16
2700	3487BE272M063DF	25*40	.046	3.69
3900	3487BF392M063DF	25*50	.034	4.70
2200	3487CC222M063DF	30*30	.080	2.86
3300	3487CD332M063DF	30*35	.060	3.48
3900	3487CE392M063DF	30*40	.049	4.04
5600	3487CF562M063DF	30*50	.036	5.12
6800	3487CG682M063FF	30*63	.027	6.47
10000	3487CH103M063FF	30*80	.021	8.05
3300	3487DC332M063DF	35*30	.092	2.95
4700	3487DD472M063DF	35*35	.070	3.57
5600	3487DE562M063DF	35*40	.057	4.14
8200	3487DF822M063DF	35*50	.041	5.25
10000	3487DG103M063FF	35*63	.030	6.66
15000	3487DH153M063FF	35*80	.024	8.28

160 VDC WORKING, 200 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
270	3487BD271M160DF	25*35	.348	1.28
330	3487BE331M160DF	25*40	.284	1.49
470	3487BF471M160DF	25*50	.202	1.94
270	3487CC271M160DF	30*30	.370	1.33
390	3487CD391M160DF	30*35	.264	1.66
470	3487CE471M160DF	30*40	.217	1.92
680	3487CF681M160DF	30*50	.153	2.48
820	3487CG821M160FF	30*63	.123	3.03
1200	3487CH122M160FF	30*80	.088	3.95
330	3487DC331M160DF	35*30	.338	1.54
560	3487DD561M160DF	35*35	.226	1.98
680	3487DE681M160DF	35*40	.184	2.30
1000	3487DF102M160DF	35*50	.130	2.96
1200	3487DG122M160FF	35*63	.101	3.68
1800	3487DH182M160FF	35*80	.073	4.74

80 VDC WORKING, 100 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
1200	3487BD122M080DF	25*35	.179	1.79
1800	3487BE182M080DF	25*40	.129	2.22
2200	3487BF222M080DF	25*50	.101	2.73
1500	3487CC152M080DF	30*30	.185	1.88
1800	3487CD182M080DF	30*35	.145	2.24
2700	3487CE272M080DF	30*40	.111	2.68
3300	3487CF332M080DF	30*50	.084	3.35
4700	3487CG472M080FF	30*63	.061	4.32
6800	3487CH682M080FF	30*80	.046	5.45
2200	3487DC222M080DF	35*30	.188	2.07
2700	3487DD272M080DF	35*35	.144	2.48
3300	3487DE332M080DF	35*40	.117	2.89
4700	3487DF472M080DF	35*50	.085	3.67
6800	3487DG682M080FF	35*63	.061	4.71
8200	3487DH822M080FF	35*80	.048	5.84

200 VDC WORKING, 250 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
220	3487BD221M200DF	25*35	.368	1.25
270	3487BE271M200DF	25*40	.300	1.45
390	3487BF391M200DF	25*50	.210	1.90
220	3487CC221M200DF	30*30	.390	1.29
270	3487CD271M200DF	30*35	.340	1.38
330	3487CE331M200DF	30*40	.271	1.64
470	3487CF471M200DF	30*50	.201	1.99
560	3487CG561M200FF	30*63	.160	2.42
390	3487CH391M200FF	30*80	.297	1.64
560	3487DC561M200DF	35*30	.218	2.02
680	3487DD681M200DF	35*35	.177	2.34
820	3487DE821M200DF	35*40	.136	2.90
1000	3487DF102M200DF	35*50	.126	3.01
1200	3487DG122M200FF	35*63	.096	3.76
1500	3487DH152M200FF	35*80	.076	4.65

100 VDC WORKING, 125 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
820	3487BD821M100DF	25*35	.220	1.61
1200	3487BE122M100DF	25*40	.158	2.01
1500	3487BF152M100DF	25*50	.124	2.47
1000	3487CC102M100DF	30*30	.212	1.75
1200	3487CD122M100DF	30*35	.170	2.07
1800	3487CE182M100DF	30*40	.124	2.53
2200	3487CF222M100DF	30*50	.097	3.12
2700	3487CG272M100FF	30*63	.076	3.85
3900	3487CH392M100FF	30*80	.056	4.95
1500	3487DC152M100DF	35*30	.199	2.01
1800	3487DD182M100DF	35*35	.154	2.40
2200	3487DE222M100DF	35*40	.125	2.79
3300	3487DF332M100DF	35*50	.090	3.57
3900	3487DG392M100FF	35*63	.067	4.49
5600	3487DH562M100FF	35*80	.051	5.66

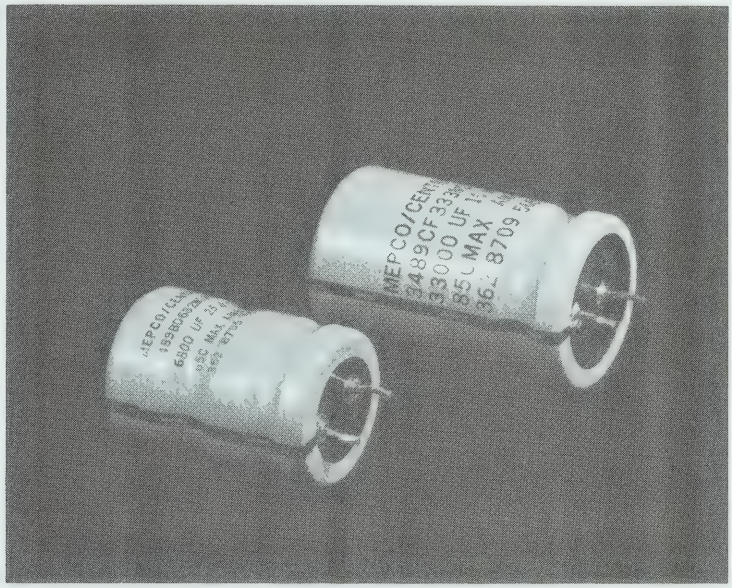
250 VDC WORKING, 300 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
180	3487BD181M250DF	25*35	.388	1.22
220	3487BE221M250DF	25*40	.317	1.41
330	3487BF331M250DF	25*50	.215	1.87
220	3487CC221M250DF	30*30	.361	1.34
270	3487CD271M250DF	30*35	.286	1.59
330	3487CE331M250DF	30*40	.234	1.85
470	3487CF471M250DF	30*50	.167	2.38
560	3487CG561M250FF	30*63	.134	2.90
330	3487CH331M250DF	30*80	.310	1.61
390	3487DC391M250DF	35*30	.247	1.90
470	3487DD471M250DF	35*35	.203	2.19
680	3487DE681M250DF	35*40	.144	2.82
820	3487DF821M250DF	35*50	.132	2.94
1000	3487DG102M250FF	35*63	.101	3.67
1200	3487DH122M250FF	35*80	.082	4.49

SUPER SNAP™ SERIES 3489

Industrial/Computer Grade Snap-In Aluminum Electrolytic Capacitor

Special Design For "Off-Line" Switching Application



DESCRIPTION

The series 3489 is specially designed for input capacitor application in off line switching power supplies. It utilizes a new snap-in configuration with integral standoffs. This allows fast and easy mounting into circuit boards. The standoffs provide space between capacitor body and PWB for easy cleaning and preventing cleaning fluid entrapment.

State of the art etching and anodizing process results in extremely high CV product in the applicable 200 and 250 W.V. area. This combined with very low E.S.R. and ripple current capability produce a capacitor ideal for off line switch mode application.

The specially designed safety vent in the top of the can minimizes PWB damage by electrolyte spill in case of venting.

All internal and external connections of the 3489 are welded to ensure integrity of all contacts.

FEATURES

ELECTRICAL

- Very high CV density.
- Capacitance from 270 to .1200
- Voltage range of 200 and 250 VDC.
- 85°C ambient operating temperature.
- 2000 hour life at 85°C with rated DC voltage applied.
- Standard capacitor tolerance of ±20%.
- Excellent high frequency response.
- Low E.S.R. with high ripple current ratings.

MECHANICAL

- Snap-in (self mounting) terminals.
- All welded connectors.
- Top mounted safety vent device for PWB protection.
- Pitchless construction (no potting compound)
- Integral standoff feet on terminal end for improved PWB cleaning.

SUPER SNAP™ SERIES 3489

200 VDC WORKING, 250 VDC SURGE

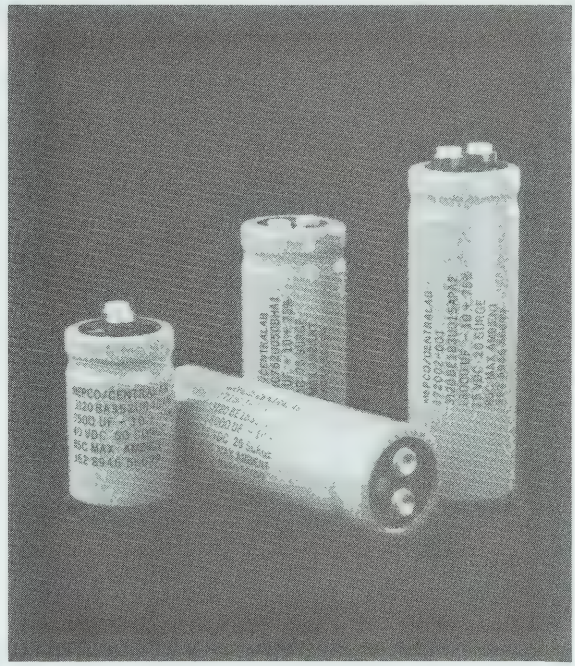
CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
330	3489BD331M200DF	25*35	.334	1.31
470	3489BE471M200DF	25*40	.242	1.62
680	3489BF681M200DF	25*50	.170	2.11
390	3489CC391M200DF	30*30	.319	1.43
560	3489CD561M200DF	30*35	.230	1.78
680	3489CE681M200DF	30*40	.188	2.06
1000	3489CF102M200DF	30*50	.132	2.67
560	3489DC561M200DF	35*30	.277	1.70
820	3489DD821M200DF	35*35	.203	2.09
1000	3489DE102M200DF	35*40	.165	2.43
1200	3489DF122M200DF	35*50	.125	3.02

250 VDC WORKING, 300 VDC SURGE

CAPACITANCE UF	PHILIPS COMPONENTS PART NUMBER	CASE SIZE	MAXIMUM ESR (OHMS) 120HZ +25C	MAX RIPPLE (AMP) 120HZ +85C
270	3489BD271M250DF	25*35	.344	1.29
330	3489BE331M250DF	25*40	.295	1.39
470	3489BF471M250DF	25*50	.200	1.94
330	3489CC331M250DF	30*30	.325	1.42
390	3489CD391M250DF	30*35	.263	1.66
470	3489CE471M250DF	30*40	.217	1.92
680	3489CF681M250DF	30*50	.153	2.48
390	3489DC391M250DF	35*30	.310	1.61
560	3489DD561M250DF	35*35	.227	1.98
680	3489DE681M250DF	35*40	.185	2.30
1000	3489DF102M250DF	35*50	.131	2.95

SERIES 3500

A.C. Motor Start Capacitor



DESCRIPTION

Philips Components Series 3500 A.C. motor-start capacitor is an electrochemical device consisting of compactly wound aluminum foil separated by layers of paper, which are impregnated with a conducting electrolyte. Etching of the foil prior to formation and winding increases both the effective foil surface area and the capacitance per unit volume of the finished capacitor. The entire assembly is housed in a molded plastic container.

Capacitors are rated for operation in ambient temperatures from −40°C to +65°C, and at a frequency of 50 Hz to 60 Hz.

Two case styles are available along with a choice of terminals and mounting methods. Four terminal types are available. All have a special metal to metal under cover connection for positive terminal contact with the capacitor roll tabs. On special order, units can be supplied with bleeder resistors soldered across the terminals.

FEATURES

- Plastic case requires no insulation.
- Stable electrical characteristics after 75,000 starts (110VAC and 125VAC).
- Type 3535 meets EIA Type I specifications.
- Type 3534 meets EIA Type II specifications.
- Longer life due to cooler operation.
- Four terminal types available.

SERIES 3500

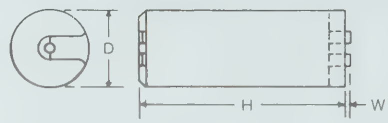
A.C. Motor Start Capacitor

CASE DIMENSIONS AND STYLES

Dimensions in Inches

Case Size	D ±0.010	H ±0.020	Case Style B W (Max)
1	1 7/16	2 3/4	0.032
2	1 7/16	3 3/8	.032
3	1 7/16	4 3/8	.032
4	1 13/16	3 3/8	.032
5	1 13/16	4 3/8	.032
6	2 1/16	3 3/8	.032
7	2 1/16	4 3/8	.032
8	2 9/16	4 3/8	.032

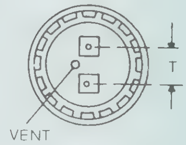
CASE OUTLINE DRAWING



Style B
(recessed cover depth)

TERMINAL SPACING

CASE SIZE	T (in.) ± .062
1, 2, 3	0.500
4, 5	0.625
6, 7, 8	0.813



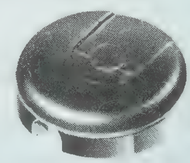
END CAPS

Bottom Lead Hole		Top Lead Hole	
Case Size	Catalog No.	Case Size	Catalog No.
1, 2, 3	614A766AAP1	1, 2, 3	614A766ABP1
4, 5	614A766AAP2	4, 5	614A766ABP2
6, 7	614A766AAP3	6, 7	614A766ABP3
8	614A766AAP4	8	614A766ABP4

END CAPS

Bottom Lead Hole

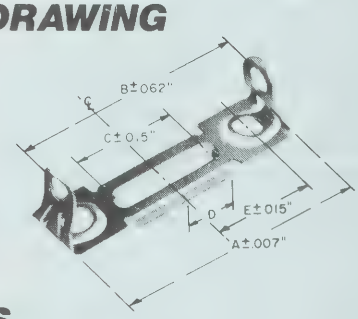
Top Lead Hole



BRACKETS

Case Size	Catalog No.	A	B	C	D	E
3,5,7,8	614A765ABP1	5.015	4.656	2.0	–	2.078
2,4,6	614A765ABP2	4.015	3.650	1.703	.906	1.578
1	614A765ABP3	3.374	3.015	1.062	.586	1.258

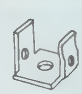
BRACKET DRAWING



LEADS AND TERMINALS

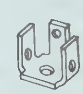
If required, leads (with or without terminals) can be supplied at extra cost. Standard lengths vary from 4 to 28 inches in 2-inch increments. Lead wire is #18 stranded copper conductor with 0.062" min. thickness thermoplastic insulation. Insulation is stripped ½" from ends, and bared lead is tinned. Upon request, leads can be supplied with terminals affixed to one end. Either eyelet or female quick-connect terminals are available.

TERMINALS



Type A
Double QC

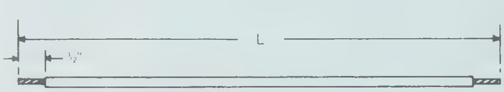
Type B
Single QC



Type C
Double QC
with solder lug

Type D
Solder lug

(Quick-connect terminals are also suitable for soldered connections).



Eyelet terminal

Female quick-connect terminal

STANDARD CAPACITANCE VALUES EIA TYPE I

110 VOLTS AC

UF Min-Max	Case Size	Part Number
21-25	1	3535B1A0021A110**
25-30	1	3535B1A0025A110**
30-36	1	3535B1A0030A110**
36-43	1	3535B1A0036A110**
43-53	1	3535B1A0043A110**
47-56	1	3535B1A0047A110**
53-64	1	3535B1A0053A110**
64-77	1	3535B1A0064A110**
72-88	1	3535B1A0072A110**
88-108	1	3535B1A0088A110**
108-130	1	3535B1A0108A110**
124-149	1	3535B1A0124A110**
130-156	1	3535B1A0130A110**
145-175	1	3535B1A0145A110**
161-193	1	3535B1A0161A110**
189-227	2	3535B2A0189A110**
216-259	2	3535B2A0216A110**
233-280	2	3535B2A0233A110**
243-292	4	3535B4A0243A110**
270-324	4	3535B4A0270A110**
340-408	4	3535B4A0340A110**
378-440	4	3535B4A0378A110**
400-480	4	3535B4A0400A110**
430-516	4	3535B4A0430A110**
460-552	4	3535B4A0460A110**
540-648	7	3535B7A0540A110**
590-708	7	3535B7A0590A110**
710-850	8	3535B8A0710A110**

125 VOLTS AC

UF Min-Max	Case Size	Part Number
21-25	1	3535B1A0021A125**
25-30	1	3535B1A0025A125**
30-36	1	3535B1A0030A125**
36-43	1	3535B1A0036A125**
43-53	1	3535B1A0043A125**
47-56	1	3535B1A0047A125**
53-64	1	3535B1A0053A125**
64-77	1	3535B1A0064A125**
72-88	1	3535B1A0072A125**
88-108	1	3535B1A0088A125**
108-130	1	3535B1A0108A125**
124-149	1	3535B1A0124A125**
130-156	1	3535B1A0130A125**
145-175	2	3535B2A0145A125**
161-193	2	3535B2A0161A125**
189-227	2	3535B2A0189A125**
216-259	4	3535B4A0216A125**
233-280	4	3535B4A0233A125**
243-292	4	3535B4A0243A125**
270-324	4	3535B4A0270A125**
340-408	5	3535B5A0340A125**
378-440	5	3535B5A0378A125**
400-480	5	3535B5A0400A125**
430-516	7	3535B7A0430A125**
460-552	7	3535B7A0460A125**
560-648	8	3535B8A0560A125**

165 VOLTS AC

UF Min-Max	Case Size	Part Number
21-25	1	3535B1A0021A165**
25-30	1	3535B1A0025A165**
30-36	1	3535B1A0030A165**
36-43	1	3535B1A0036A165**
43-53	1	3535B1A0043A165**
47-56	1	3535B1A0047A165**

165 VOLTS AC

UF Min-Max	Case Size	Part Number
53-64	1	3535B1A0053A165**
64-77	1	3535B1A0064A165**
72-88	1	3535B1A0072A165**
88-108	2	3535B2A0088A165**
108-130	2	3535B2A0108A165**
124-149	4	3535B4A0124A165**
130-156	4	3535B4A0130A165**
145-175	4	3535B4A0145A165**
161-193	4	3535B4A0161A165**
189-227	4	3535B4A0189A165**
216-259	5	3535B5A0216A165**
233-280	5	3535B5A0233A165**
243-292	5	3535B5A0243A165**
270-324	5	3535B5A0270A165**
340-408	7	3535B7A0340A165**
400-480	8	3535B8A0400A165**

220 VOLTS AC

UF Min-Max	Case Size	Part Number
21-25	1	3535B1A0021A220**
25-30	1	3535B1A0025A220**
30-36	1	3535B1A0030A220**
36-43	2	3535B2A0036A220**
43-53	2	3535B2A0043A220**
47-56	2	3535B2A0047A220**
53-64	4	3535B4A0053A220**
64-77	4	3535B4A0064A220**
72-88	4	3535B4A0072A220**
88-108	4	3535B4A0088A220**
108-130	5	3535B5A0108A220**
124-149	5	3535B5A0124A220**
130-156	5	3535B5A0130A220**
145-175	7	3535B7A0145A220**
161-193	8	3535B8A0161A220**
189-227	8	3535B8A0189A220**

250 VOLTS AC

UF Min-Max	Case Size	Part Number
21-25	1	3535B1A0021A250**
25-30	1	3535B1A0025A250**
30-36	2	3535B1A0030A250**
36-43	2	3535B2A0036A250**
43-53	4	3535B4A0043A250**
47-56	4	3535B4A0047A250**
53-64	4	3535B4A0053A250**
64-77	4	3535B4A0064A250**
72-88	4	3535B4A0072A250**
88-108	5	3535B5A0088A250**
108-130	5	3535B5A0108A250**
124-149	7	3535B7A0124A250**
130-156	8	3535B8A0130A250**
145-175	8	3535B8A0145A250**
161-193	8	3535B8A0161A250**

330 VOLTS AC

UF Min-Max	Case Size	Part Number
21-25	2	3535B2A0021A330**
25-30	2	3535B2A0025A330**
30-36	4	3535B4A0030A330**
36-43	4	3535B4A0036A330**
43-53	4	3535B4A0043A330**
47-56	4	3535B4A0047A330**
53-64	5	3535B5A0053A330**
64-77	5	3535B5A0064A330**
72-88	5	3535B5A0072A330**
88-108	7	3535B7A0088A330**
108-130	8	3535B8A0108A330**

NOTE: **Last two digits of part number to be assigned by the computer for individual customer identification. Part numbers shown are for standard parts. Recessed case, double quick connect terminals.

SERIES 3500

A.C. Motor Start Capacitor

STANDARD CAPACITANCE VALUES EIA. TYPE II

UF Min-Max	Case Size	Part Number
110 VOLTS AC		
21-25	1	3534B1A0021A110**
25-30	1	3534B1A0025A110**
30-36	1	3534B1A0030A110**
36-43	1	3534B1A0036A110**
43-53	1	3534B1A0043A110**
47-56	1	3534B1A0047A110**
53-64	1	3534B1A0053A110**
64-77	1	3534B1A0064A110**
72-88	1	3534B1A0072A110**
88-108	1	3534B1A0088A110**
108-130	1	3534B1A0108A110**
124-149	1	3534B1A0124A110**
130-156	1	3534B1A0130A110**
145-175	1	3534B1A0145A110**
161-193	1	3534B1A0161A110**
189-227	1	3534B1A0189A110**
216-259	2	3534B2A0216A110**
233-280	2	3534B2A0233A110**
243-292	2	3534B2A0243A110**
270-324	2	3534B2A0270A110**
340-408	4	3534B4A0340A110**
378-440	4	3534B4A0378A110**
400-480	4	3534B4A0400A110**
430-516	4	3534B4A0430A110**
460-552	4	3534B4A0460A110**
540-648	5	3534B5A0540A110**
590-708	5	3534B5A0590A110**
710-850	7	3534B7A0710A110**
829-995	7	3534B7A0829A110**
1000-1200	8	3534B8A1000A110**
125 VOLTS AC		
21-25	1	3534B1A0021A125**
25-30	1	3534B1A0025A125**
30-36	1	3534B1A0030A125**
36-43	1	3534B1A0036A125**
43-53	1	3534B1A0043A125**
47-56	1	3534B1A0047A125**
53-64	1	3534B1A0053A125**
64-77	1	3534B1A0064A125**
72-88	1	3534B1A0072A125**
88-108	1	3534B1A0088A125**
108-130	1	3534B1A0108A125**
124-149	1	3534B1A0124A125**
130-156	1	3534B1A0130A125**
145-175	1	3534B1A0145A125**
161-193	1	3534B1A0161A125**
189-227	2	3534B2A0189A125**
216-259	2	3534B2A0216A125**
233-280	2	3534B2A0233A125**
243-292	3	3534B3A0243A125**
270-324	3	3534B3A0270A125**
340-408	4	3534B4A0340A125**
378-440	4	3534B4A0378A125**
400-480	4	3534B4A0400A125**
430-516	4	3534B4A0430A125**
460-552	4	3534B4A0460A125**
560-648	5	3534B5A0560A125**
645-774	7	3534B7A0645A125**
829-995	8	3534B8A0829A125**
165 VOLTS AC		
21-25	1	3534B1A0021A165**
25-30	1	3534B1A0025A165**
30-36	1	3534B1A0030A165**
36-43	1	3534B1A0036A165**
43-53	1	3534B1A0043A165**
47-56	1	3534B1A0047A165**
53-64	1	3534B1A0053A165**
64-77	1	3534B1A0064A165**

UF Min-Max	Case Size	Part Number
165 VOLTS AC		
72-88	1	3534B1A0072A165**
88-108	1	3534B1A0088A165**
108-130	2	3534B2A0108A165**
124-149	2	3534B2A0124A165**
130-156	4	3534B4A0130A165**
145-175	4	3534B4A0145A165**
161-193	4	3534B4A0161A165**
189-227	4	3534B4A0189A165**
216-259	4	3534B4A0216A165**
233-280	5	3534B5A0233A165**
243-292	5	3534B5A0243A165**
270-324	5	3534B5A0270A165**
340-408	7	3534B7A0340A165**
400-480	7	3534B7A0400A165**
460-552	8	3534B8A0460A165**
220 VOLTS AC		
21-25	1	3534B1A0021A220**
25-30	1	3534B1A0025A220**
30-36	1	3534B1A0030A220**
36-43	1	3534B1A0036A220**
43-53	2	3534B2A0043A220**
47-56	2	3534B2A0047A220**
53-64	2	3534B2A0053A220**
64-77	4	3534B4A0064A220**
72-88	4	3534B4A0072A220**
88-108	4	3534B4A0088A220**
108-130	4	3534B4A0108A220**
124-149	5	3534B5A0124A220**
130-156	5	3534B5A0130A220**
145-175	7	3534B7A0145A220**
161-193	7	3534B7A0161A220**
189-227	7	3534B7A0189A220**
233-280	8	3534B8A0233A220**
270-324	8	3534B8A0270A220**
250 VOLTS AC		
21-25	1	3534B1A0021A250**
25-30	1	3534B1A0025A250**
30-36	2	3534B2A0030A250**
36-43	2	3534B2A0036A250**
43-53	2	3534B2A0043A250**
47-56	2	3534B2A0047A250**
53-64	4	3534B4A0053A250**
64-77	4	3534B4A0064A250**
72-88	4	3534B4A0072A250**
88-108	5	3534B5A0088A250**
108-130	5	3534B5A0108A250**
124-149	5	3534B5A0124A250**
130-156	5	3534B5A0130A250**
145-175	7	3534B7A0145A250**
161-193	7	3534B7A0161A250**
189-227	8	3534B8A0189A250**
233-280	8	3534B8A0233A250**
330 VOLTS AC		
21-25	2	3534B2A0021A330**
25-30	2	3534B2A0025A330**
30-36	4	3534B4A0030A330**
36-43	4	3534B4A0036A330**
43-53	4	3534B4A0043A330**
47-56	4	3534B4A0047A330**
53-64	5	3534B5A0053A330**
64-77	5	3534B5A0064A330**
72-88	5	3534B5A0072A330**
88-108	7	3534B7A0088A330**
108-130	8	3534B8A0108A330**
124-149	8	3534B8A0124A330**
145-174	8	3534B8A0145A330**

NOTE: **Last two digits of part number to be assigned by the computer for individual customer identification. Part numbers shown are for standard parts. Recessed case, double quick connect terminals.

PERFORMANCE SPECIFICATIONS

1. **TEMPERATURE.**

1.1 Operating. These capacitors are designed to operate within the ambient temperature range of −40°C to 65°C.

1.2 Storage. These capacitors may be subjected, without permanent damage, to conditions in transit where temperatures range from −55°C to +95°C.

1.3 Tolerance. Unless otherwise specified, temperature tolerance shall be ±3°C.

2. **FREQUENCY.** Unless otherwise specified, frequency shall be 50-60 Hz.

3. **VOLTAGE RATING.** The rated voltage is the rms value of AC voltage at which the capacitor may be operated at its normal duty cycle and maximum ambient temperature.

4. **CAPACITANCE AND POWER FACTOR.**

4.1 Measurement. Using the circuit shown in Fig.1, apply rated voltage to the capacitor and measure current and power dissipated. Current shall be measured within 3 seconds, dissipated power within 4 seconds after application of rated voltage.

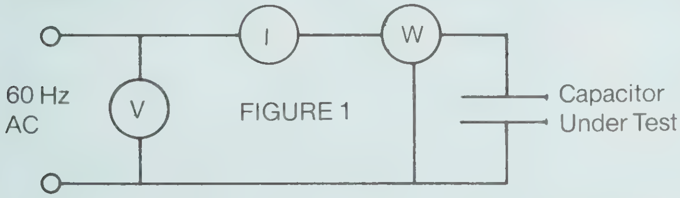


FIGURE 1

4.2 Temperature. Measurement shall be made at, or referred to, a temperature of 25°C.

4.3 Calculation of Capacitance and Power Factor.

$$C = \frac{I \times 10^6}{2\pi f V} \qquad \%PF = \frac{W}{VI} \times 100$$

Where C is capacitance in ufs
I is current in amperes
π is a constant (3.14)
f is frequency in hertz
V is applied voltage
PF is the power factor
W is power dissipated in watts

4.4 Requirements. Capacitance shall be within specified limits and the power factor shall not exceed 10%.

5. **LIFE TEST.***

5.1 Capacitors shall be placed in a circulating air oven at an ambient temperature of 65°C. Spacing between capacitors must be at least 1″ and capacitors must not be subjected to direct radiation from heating elements. Circulation of air shall be sufficient to keep the temperature, within six (6) inches of the capacitor, below 68°C.

* Caution—Confine capacitor(s) under test to isolate all electrical connections for the safety of personnel.

5.1.1 A resistance equivalent to approximately 10% of the capacitor impedance shall be connected in series with each capacitor. A resistor of approximately 1000 ohms shall be connected in parallel with each capacitor.

5.1.2 Rated voltage shall be applied to the capacitor resistor combination for 3535 capacitors EIA Type I as specified below. Table is per EIA Standard RS-463.

Rated Voltage	Voltage Cycle	Duty Cycle	Minimum Number Starts
110, 115 and 125	2 times per minute ¾ sec. on; 29¼ sec. off.	0.0250	75,000
165, 220, 250 and 330	1 time per minute 1 sec. on; 59 sec. off.	0.0167	40,000

SERIES 3500

A.C. Motor Start Capacitor

5.1.3 Rated voltage shall be applied to the capacitor resistor combination for 3534 capacitors EIA Type II as specified below. Table is per EIA Standard RS-463.

Rated Voltage, Test Voltage as (rms)	Capacitance Rating (mfd)		Duty Cycle		Duration of Test* (Number of Starts)
	From	To	Seconds On	Seconds Off	
110	21-25	124-149	3/4	29 1/4	50,000
	130-156	243-292	1	59	50,000
	270-324	378-454	1	89	33,500
	400-480	540-648	1	119	25,000
	590-708	850-1020	1	179	16,500
	1000-1200	1280-1546	1	239	12,500
115	21-25	108-130	3/4	29 1/4	50,000
	124-149	189-227	1	59	50,000
	216-259	340-408	1	89	33,500
	378-454	460-552	1	119	25,000
	540-648	815-978	1	179	16,500
	829-995	1020-1224	1	239	12,500
125	21-25	88-106	3/4	29 1/4	50,000
	108-130	145-174	1	59	50,000
	161-193	233-280	1	89	33,500
	243-292	378-454	1	119	25,000
	400-480	590-708	1	179	16,500
	645-774	800-960	1	239	12,500
165	21-25	88-106	1	59	33,500
	108-130	124-149	1	89	33,500
	130-156	216-259	1	119	25,000
	233-280	340-408	1	179	16,500
	378-454	590-708	1	239	12,500

* The number of starts shown in this column are reduced starts for accelerated testing so that test time does not exceed 35 days. Type 2 capacitors should be capable of 50,000 starts for ratings to 125 volts and 40,000 starts for higher voltages.

5.2 Upon completion of the life test, the capacitors shall be returned to room ambient for a minimum of 24 hours.The capacitors shall then meet the following requirements:

5.2.1 Capacitance, when measured per paragraph 4, shall not differ from the initial measured value by more than 25%.

5.2.2 The power factor, when measured per paragraph 4, shall not exceed 20%.

6. **OVERVOLTAGE TEST.** Capacitors shall withstand, without breakdown or visible mechanical damage, 140% of rated voltage for one second at room temperature (EIA Type I capacitors only).

7. **TERMINAL STRENGTH.** At the point of normal lead connection, terminals shall withstand a force of 5 pounds applied gradually in any direction for a period of one minute. There shall be no loosening of the terminals or damage to the terminal or seal.

8. **CASE INSULATION.** Capacitors are designed to withstand a 1500-volt rms 60-cycle voltage applied for 5 seconds between terminals and case without breakdown or flashover.

Rated Voltage, Test Voltage ac (rms)	Capacitance Rating (mfd)		Duty Cycle		Duration of Test * (Number of Starts)
	From	To	Seconds On	Seconds Off	
220	21-25	43-52	1	59	33,500
	37-56	72-86	1	89	33,500
	88-106	145-174	1	119	25,000
	161-193	243-292	1	179	16,500
	270-324	430-516	1	239	12,500
250	21-25	30-36	1	59	33,500
	36-43	64-77	1	89	33,500
	72-86	88-106	1	119	25,000
	108-130	189-227	1	179	16,500
	216-259	324-389	1	239	12,500
330	21-25	21-25	1	59	33,500
	25-30	30-36	1	89	33,500
	36-43	64-77	1	119	25,000
	72-86	88-106	1	179	16,500
	108-130	130-156	1	239	12,500

* The number of starts shown in this column are reduced starts for accelerated testing so that test time does not exceed 35 days. Type 2 capacitors should be capable of 50,000 starts for ratings to 125 volts and 40,000 starts for higher voltages.

9. **VIBRATION.** Capacitors shall be clamped rigidly to a vibration platform and subjected to a simple harmonic motion having a maximum peak-to-peak amplitude of .06 inches and a maximum acceleration of 10g. The frequency of vibration shall be varied linearly between 10 and 55 cycles per second. The entire frequency range, 10 to 55 to 10 cps, shall be traversed in one minute. Capacitors shall be vibrated for 1½ hours with the direction of motion being parallel to the axis of the capacitor. The capacitors shall then be placed so that the direction of motion is perpendicular to the axis and the vibration continued for 1½ hours. During the last ½ hour of the test, the capacitor shall be connected to a bridge and observed for a 3 minute period. A capacitor failing the vibration test is defined as one failing to meet the requirements of paragraph 9.1.

9.1 There shall be no evidence of loosening of the capacitor element within the container, when shaken by hand following the test. There shall be no indication of intermittent contact during the 3 minute observation period. Capacitors shall not be open or shorted.

10. **MARKING.** Capacitors will have the following minimum marking:

Manufacturer's Name And/Or Symbol
Manufacturer's Part Number
Capacitance (Min-Max Mfd)
Rated Voltage
Rated Frequency
EIA Source and Date Code

APPLICATION GUIDELINES

The Philips Components AC Motor Start capacitors are non-polar aluminum electrolytic capacitors designed for intermittent AC duty; more specifically, the starting of small AC motors. They are not suitable for most DC or continuous AC applications.

1. **DUTY CYCLE.** The duty cycle of an AC Motor Start capacitor may be determined by dividing the capacitor's on-time (energized time) by the sum of its on-time (energized time) and its off-time (de-energized time). For a given AC Motor Start capacitor, operating at a given voltage and ambient temperature; the time-averaged power dissipated by the capacitor, the internal operating temperature of the capacitor and, therefore, the life expectancy of the capacitor are all directly proportional to the capacitor's duty cycle.

1.1 Normal capacitor life may be realized (assuming voltage and temperature limits are not exceeded) when the on-time of a capacitor does not exceed 3 seconds and its duty cycle does not exceed 0.0167. Example: Twenty (20) three (3) second starts per hour yield a duty cycle of 0.0167 and does not exceed the three (3) second on-time limit.

1.2 Longer than 3 second on-times are not recommended as they will cause the capacitor's life to be shortened. Should they be unavoidable, there are certain things that can be done to minimize the degradation of the capacitor's life expectancy. For on-times up to 6 seconds:

- Reduce the duty cycle by increasing the off-time
- Reduce the ambient temperature
- Provide forced air cooling
- Use a capacitor with a higher voltage rating
- Series two capacitors each having twice the mfd value of the original.

2. **FREQUENCY.** These capacitors are designed for and are tested at 60 Hz. They are, however, suitable for use from 50 to 60 Hz.

3. **VOLTAGE.** Rated voltage and overvoltage (proof test) have been covered in the PERFOR—MANCE SPECIFICATIONS section and will not be reiterated here. However, there is a third voltage that should be considered in the application of AC Motor Start capacitors.

During the start cycle of a normal capacitor motor, the voltage impressed across the AC motor start capacitor does not remain constant. It should start close to the rated voltage, dip slightly and then begin to increase as the motor's RPM increases. Should the start switch fail to open, it is possible for the capacitor's voltage to increase to as much as 2 to 3 times the capacitor's rated voltage.

SERIES 3500

A.C. Motor Start Capacitor

3.1 Normal capacitor life may be realized (assuming temperature and duty cycle limits are not exceeded) when, during the start cycle, the voltage impressed across the capacitor does not exceed 125% of its rated voltage.

4. **TEMPERATURE.** The storage and operating temperatures have been covered in the PERFORMANCE SPECIFICATIONS section. There has been some misunderstanding about the −40°C lower limit. As the temperature decreases from room temperature, capacitance starts to fall and % power factor (measurement of losses) starts to rise. Either one of these effects will cause a decrease in a motor's starting torque. The effects are such that below −40°C, a stalled rotor condition could occur. However, because the losses are so high, the internal capacitor temperature will rise rather quickly, thus restoring normal start torque. The total effect may just be a delay in the motor reaching switch out speed.

5. **SHELF LIFE.** The normal shelf life expectancy for these capacitors is typically in excess of 5 years when stored in ambient temperatures not exceeding 40°C.

6. **RESISTORS.** Some specialized applications require that the motor start capacitor be discharged prior to the closing of the start switch. This minimizes shock hazard, Switch Bounce noise, and peak contact currents. The resistor used to discharge the capacitor should be large enough so as not to significantly increase the power factor and small enough to insure discharging the capacitor within the time required. Normally, a 15K ohm ±20% 2-watt resistor is used. Consult factory for this option.

7. **MOUNTING.** Vertical mounting of the capacitor with the terminals up is recommended; however, horizontal mounting with the pressure relief vent up is acceptable. Vertical mounting with terminals down or horizontal mounting with a relief vent down is not recommended as they may reduce capacitor life and could impair the operation of the pressure relief vent.

8. **CLEANING SOLVENTS.** Recommended cleaning solvents are those free of halogens or halogen groups such as ethyl alcohol, butyl alcohol, methyl alcohol, propyl alcohol and deionized or distilled water.

Solvents that are NOT recommended are halogenated hydrocarbon solvents such as Freon TF,® Freon TMC,® carbon tetrachloride, chloroform, trichloroethylene, trichloroethane, and methylene chloride.

9. **SAFETY.** The watt-second capability of these capacitors is high enough that precautions should be taken during the testing and application of these devices. Normally, the DC series resistance of the main and auxiliary windings are such that the capacitor is completely discharged prior to the motor coming to a complete stop. However, if this is not the case, or if this is deemed inadequate, discharge resistors are available from the factory.

9.1 **Misapplication, such as exceeding design limits or applying continuous AC voltage, may result in destruction or explosion of capacitors.**

9.2 **Care should be exercised in the mounting of these capacitors to insure minimal damage in the event of an explosion.**

10. **GENERAL.** In the event that application requirements exceed the parameters expressed herein, it is often possible to use a standard capacitor, providing certain "tradeoffs" are acceptable. It is also possible that special designs and/or manufacturing techniques not normally included, could be applied to meet a special situation.

10.1 When consulting the factory about a special application or an application problem, the following minimum information should be available:

a. Capacitor nameplate information; MFD value, voltage, etc.
b. Case size (diameter x length)
c. Capacitor's worst case duty cycle
d. Maximum switch out voltage
e. Maximum ambient temperature
f. Any special or unusual application characteristic

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1. TEMPERATURE

These capacitors are designed to operate without derating within the temperature ranges indicated in the following table. Under non-operating conditions they may be subjected to temperatures in storage, or in transient at altitudes up to the indicated maximum, as shown under NON-OPERATING in TABLE I, without permanent damage.

Where a nominal temperature is indicated for performing standard measurements or tests in this catalog, the temperature tolerance will be ±3°C unless otherwise specified.

TABLE I
AMBIENT TEMPERATURE RANGE

CAPACITOR SERIES	OPERATING TEMP. (°C)	NON-OPERATING	
		TEMP. (°C)	MAX. ALTITUDE (ft.)
3120	−40 to +105	−55 to +85	200,000
3186	−40 to +85	−55 to +85	80,000
3188	−40 to +105	−55 to +85	80,000
3191	−40 to +85	−55 to +85	200,000
3487	−40 to +85	−55 to +85	80,000
3488	−40 to +105	−55 to +85	80,000
3489	−40 to +85	−55 to +85	80,000

Low Temperature Peformance: To determine the typical capacitance and inpedance at −40°C and at a frequency of 120 Hz multiply the 25°C measurement times the appropriate multiplier below.

Series	Rated DC Voltage	25°C Cap Multiplier	25°C Impedance Multiplier
3120, 3191	0-9 10-75 76-250	50 60 85	5.5 4.5 2.0
3186, 3188, 3487, 3488, 3489	0-75 76-250 251-450	35 70 30	9.0 4.0 6.0

2. DC WORKING VOLTAGE

The DC working voltage is the maximum permissible operating voltage (DC volts + peak ripple voltage) for continuous operation at maximum rated temperature.

3. SURGE VOLTAGE

The surge voltage is the maximum instantaneous voltage to which the capacitor should be subjected (DC voltage + ripple voltage + transient voltage). It must not exceed the value specified in the Standard Rating tables.

SURGE TEST REQUIREMENTS:

Capacitors shall be connected in series with a resistor of the value indicated:

CAPACITANCE (μF)	RESISTOR (ohms)
0–2500	1000
2501–25000	100
25001–250000	10
250001–UP	3

The series combination is then subjected to rated surge voltage at the conditions specified in TABLE 2. The capacitor is allowed to discharge through the resistor. Leakage current, when measured as described in paragraph 6 below, not sooner than four hours after completion of the test, shall not exceed the initial leakage current limit. There shall be no leaking of the electrolyte and no mechanical damage.

TABLE 2

PRODUCT TYPE	TEMPERATURE °C	NO. CYCLES	DUTY SEC. ON	CYCLE SEC. OFF
3487	25	144	30	570
3488	25	144	30	570
3489	25	144	30	570
3120	85	1000	30	330
3186	25	144	30	570
3188	25	144	30	570
3191	85	1000	30	330

4. CAPACITANCE

Capacitance shall be measured on a capacitance bridge having a maximum RMS signal voltage of 1 volt at 120Hz. Capacitance shall be within the tolerance specified in TABLE 3 when measured at 25°C.

Aluminum Electrolytic Capacitors

Performance Specifications

TABLE 3

CAPACITOR SERIES	DC WORKING VOLTAGE	TOLERANCE (%)
3487	6.3–450	−20 +20
3488	6.3–250	−20 +20
3489	200–250	−20 +20
3120	6–50 51–300	−10 +75 −10 +50
3186	5–100 101–450	−10 +75 −10 +50
3188	5–75 76–400	−10 +75 −10 +50
3191	5–55	−20 +20

5. EQUIVALENT SERIES RESISTANCE (ESR)

The ESR shall be measured by the bridge method at the frequency specified in the rating tables and 25°C. It shall be within the limits shown in the rating tables.

6. DC LEAKAGE CURRENT TEST

Preconditioning: In the period 24 to 48 hours prior to test, rated working voltage shall be applied to the capacitor for the charge times shown in TABLE 4.

Measurement: The leakage current shall be measured at 25 C. Voltage shall be applied to the capacitor through a current-limiting resistor, and the measurement shall be made five minutes after the capacitor reaches rated voltage. Leakage current (I_L) shall not exceed the value calculated from the equation shown in TABLE 4. In no case, however, shall I_L exceed the maximum value shown.

TABLE 4
Leakage Current Formulas

TIME SERIES	PRE-CONDITIONING EQUATION (MINUTES)	EQUATION I-MA	MAX. VALUE (MA)
3487 3489	30 30	$.006\sqrt{CV}$	6
3488 (CV $\leq$ 250,000)	30	6×10^{-6} CV	4
(CV $>$ 250,000)	30	$.003\sqrt{CV}$	4
3120	30	$.001\sqrt{CV}$	N/A
(6–100V) (101–300V)	30	$.003\sqrt{CV}$	N/A
3186	30	$.006\sqrt{CV}$	6
3188 (CV $\leq$ 250,000)	30	6×10^{-6} CV	4
(CV $>$ 250,000)	30	$.003\sqrt{CV}$	4
3191	15	$.0015\sqrt{CV}$	N/A

7. LIFE TEST

Capacitors to be tested will first be measured for DC leakage current, capacitance & ESR at 25°C. The capacitors shall then be placed in a circulating-air oven and kept at the ambient temperature indicated in TABLE 5, Column A. Spacing between capacitors shall be at least 1″, and capacitors must not be subjected to direct radiation from heating elements. Circulation of air shall be sufficient to keep the temperature within the limits shown when measured within six inches of the capacitors.

Rated DC voltage or rated DC voltage with ripple current shall be applied to the capacitors as indicated in Table 5, Column C, for the period of time shown in Column B. The capacitors shall then be returned to a temperature of 25°C for at least 24 hours.

Upon completion of the test, the capacitors shall meet the following requirements:

Capacitance, when measured per paragraph 4, shall not be less than the value indicated in TABLE 5, Column D.

Equivalent Series Resistance (ESR) when measured per paragraph 5, shall not be greater than the value indicated in TABLE 5, Column E.

Leakage Current, when measured and determined per paragraph 6, shall not exceed the value indicated in TABLE 5, Column F.

There shall be no evidence of mechanical damage or excessive electrolyte leakage.

8. SHELF TEST

Capacitors to be tested shall first be measured for DC leakage current, capacitance and ESR at 25°C. The capacitors shall then be placed in a circulating-air oven and kept at the ambient temperature indicated in TABLE 6, Column A. Spacing between capacitors shall be at least 1″, and capacitors must not be subjected to direct radiation from heating elements. Circulation of air shall be sufficient to keep the temperature within the limits shown, when measured within six inches of the capacitor.

The capacitors shall be kept in this environment for the period shown in TABLE 6, Column B, with no voltage applied. They shall then be allowed to cool in an ambient temperature of 25°C for at least the period time indicated in Column C.

Upon completion of the test, the capacitors shall meet the following requirements:

Leakage Current, when measured without preconditioning per paragraph 6, shall not exceed the value shown in TABLE 6, Column F.

Capacitance and ESR as indicated in TABLE 6, Columns D & E respectively.

There shall be no evidence of mechanical damage or excessive electrolyte leakage.

Shelf Life. The normal shelf life expectancy for these capacitors when stored at ambient temperatures of 40°C or below is indicated in TABLE 6, Column G. When stored for longer periods, and/or at higher temperatures, their leakage current should be checked at room temperature in accordance with the original requirement, before placing the capacitors in service. If the leakage current exceeds the value calculated from the formulas in TABLE 4, refer to Technical Note on Reform Procedures.

9. VIBRATION
Series 3186, 3188, 3191, 3487, 3488, 3489

Capacitors shall be clamped rigidly to a vibration platform and subjected to a simple harmonic motion having a maximum peak-to-peak amplitude of .06 inches and a maximum acceleration of 10g. The entire frequency of vibration shall be varied linearly between 10 and 55 cycles per second. The frequency range, 10 to 55 to 10 cps, shall be traversed in one minute.

Capacitors shall be vibrated for 1½ hours with the direction of motion being parallel to the axis of the capacitor. The capacitor shall then be placed so that the direction of motion is perpendicular to the axis and the vibration continued for an additional 1½ hours.

During the last ½ hour of the test, the capacitor shall be connected to a bridge and observed for a 3-minute period.

There shall be no evidence of loosening of the capacitor element within the container, when shaken by hand, following the test. There shall be no indication of intermittent electrical contact during the 3-minute observation period. Capacitors shall not be open or shorted.

Aluminum Electrolytic Capacitors

Performance Specifications

HIGH VIBRATION

UPON SPECIAL REQUEST a 3120 type capacitor is available to meet the following test. Capacitors shall be clamped rigidly to a vibration platform and subjected to a simple harmonic motion having a maximum peak-to-peak amplitude of .06 inches and a maximum acceleration of 20g. The frequency of vibration shall be varied logarithmically between 10 and 2000 cycles per second. The entire frequency range, 10 to 2000 to 10 cps, shall be traversed in 20 minutes. This cycle may be repeated two times in each of three mutually perpendicular directions, the first being such that the direction of motion is parallel to the axis of their containers.

At some time during the last half hour of the test each component on test shall be connected for capacitance measurement and its capacitance shall be observed for a period of approximately three (3) minutes.

There shall be no evidence of loosening of the capacitor element within the container as evidenced by shaking. There shall be no indication of intermittent connection during the three (3) minute observation period. Capacitors shall not be open or shorted.

10. CONTAINER SEAL TEST

SERIES 3186, 3188, 3120, 3191, 3487, 3488, 3489: Following the Vibration Test of paragraph 9, capacitors shall be subjected to two successive temperature cycles in circulating air. Each cycle will be as follows:

A	85°C—30 minutes
B	25°C—30 minutes
C	−40°C—30 minutes
D	25°C—30 minutes

Following the second cycle, the capacitors shall be placed in 90—95°C water for 5 minutes. A failure is defined as a unit exhibiting a continuous chain of bubbles when immersed.

TABLE 5
LIFE TEST

Series	A Ambient Temp. (°C ±3°C)	B Test Period Hours (±8 Hrs.)	C Test Conditions	D Cap. Min. (%)*	E ESR Max. (%)*	F Leakage Current Max. (%)**
3186, 3487, 3489	85	2000	DC Voltage	90	175	100
	85	1000	DC Voltage & Ripple			
	95	1000	DC Voltage			
3188, 3488	85	4000	DC Voltage	85	175	100
	85	2000	DC Voltage & Ripple			
	105	2000	DC Voltage			
3120	85	4000	DC Voltage	85	175	100
	85	3000	DC Voltage & Ripple			
	105	3000	DC Voltage			
	105	1000	DC Voltage With 25% of 85°C Ripple			
3191	85	3000	DC Voltage	85	175	100
	85	1500	DC Voltage & Ripple			
	100	1500	DC Voltage			

*Referred to initial measured value
**Referred to initial specification limit

TABLE 6
SHELF TEST

Capacitor Series	A Ambient Temp. (°C ±3°C)	B Test Period (hrs.)	C Test Period @ 25°C (hrs.)	D Cap. Min. (%)*	E ESR Max. (%)*	F Leakage Current (%)*	G Shelf Life Expectancy (years)
3120	85	500 ±8	24	100	100	200	5
3186, 3487, 3489	85	100 ±4	24	100	100	200	3
3188, 3488	85	250 ±4	16	100	100	100	4
3191	85	100 ±4	16	100	100	200	3

*Referred to original specification
**Referred to initial specification

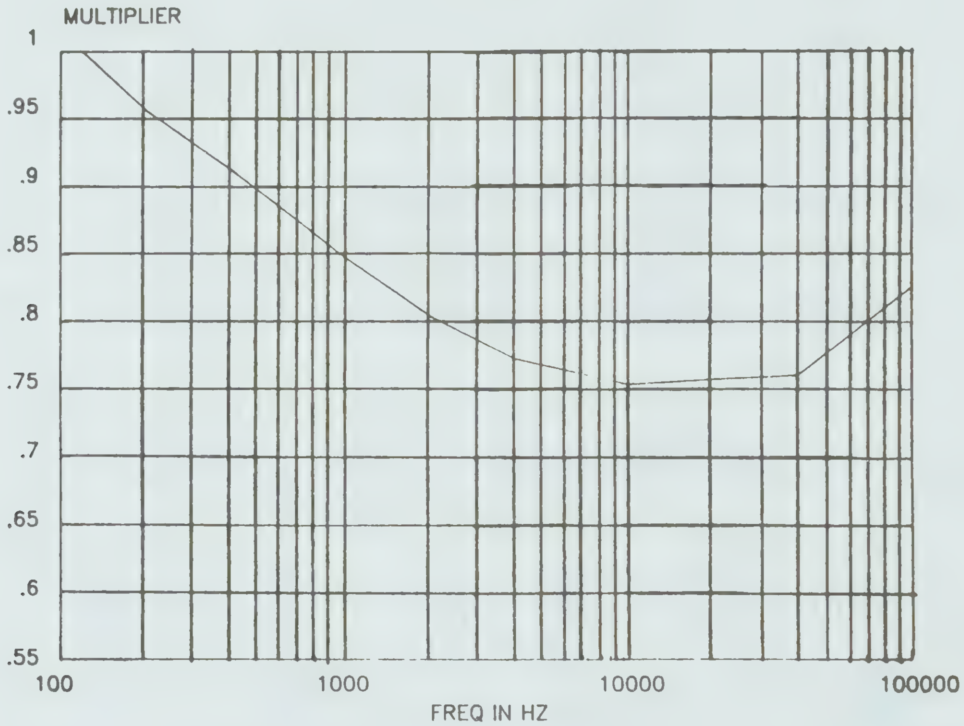
Application Guidelines

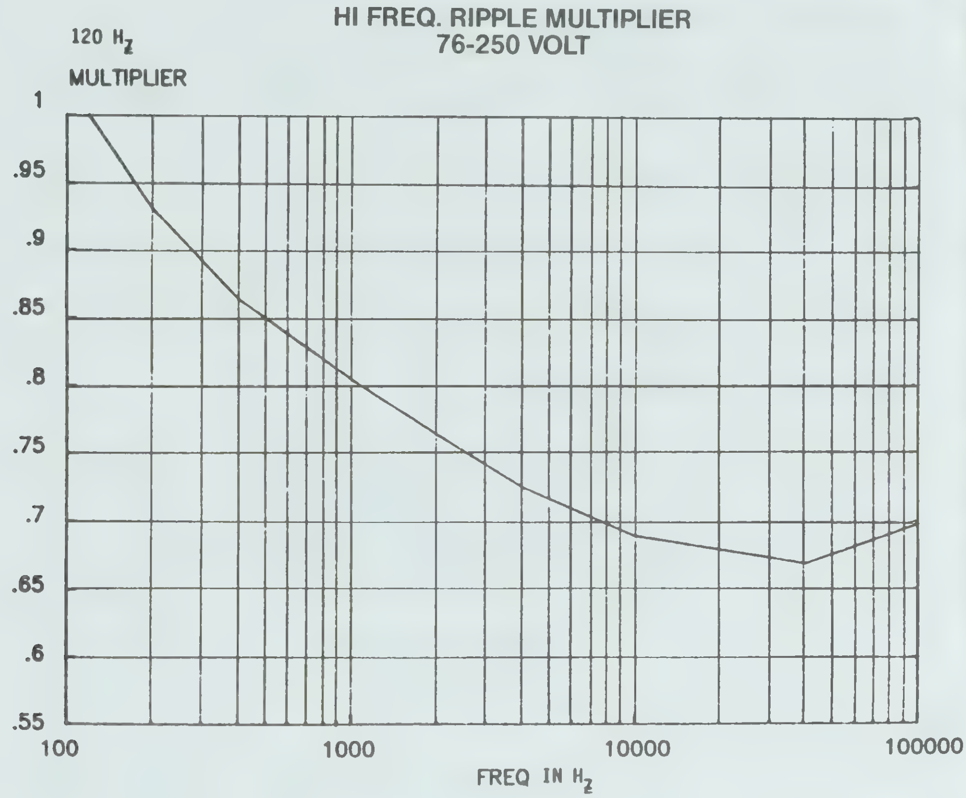
Computer Grade & Snap-in

1. TYPICAL ESR AS A FUNCTION OF FREQUENCY.

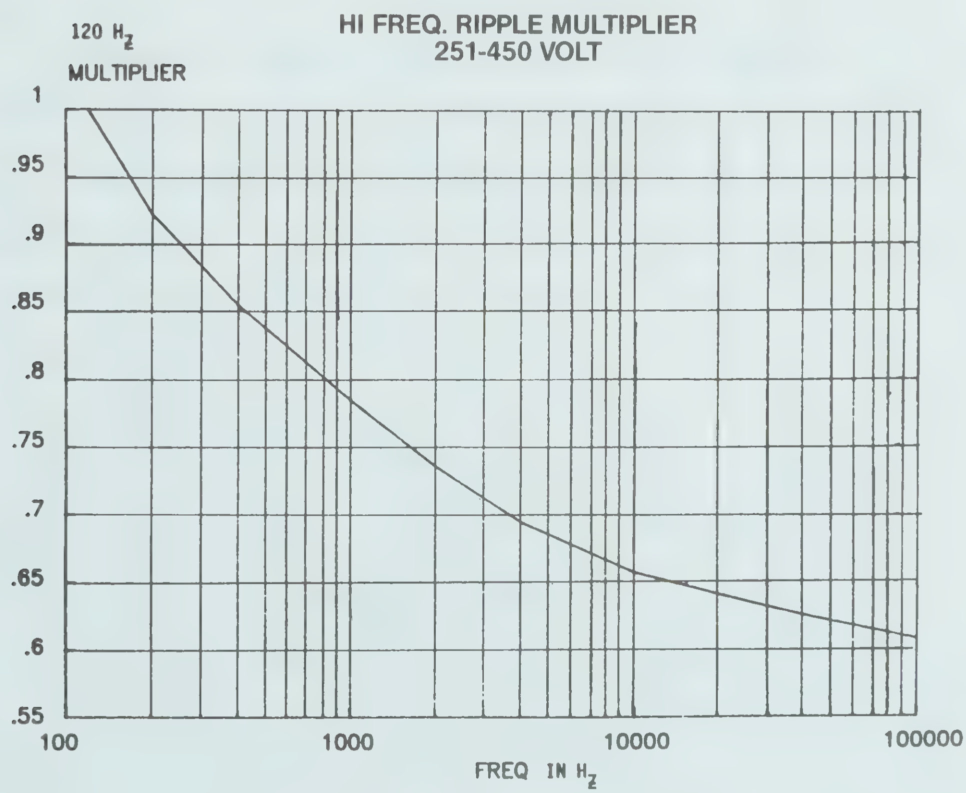
The three curves listed represent the ratio of ESR change from 120 Hz to 100 KHz. They are categorized into three voltage ranges and are valid for all the computer grade and snap-in type units. To obtain the ESR of a unit at a frequency above 120Hz, find the ratio of change from the appropriate curve. Multiply the listed 120 Hz ESR of the subject unit by the ratio, the result is the ESR at the desired frequency.

HI FREQ. RIPPLE MULTIPLIER
0-75 VOLT





HI FREQ. RIPPLE MULTIPLIER
76-250 VOLT
120 Hz
MULTIPLIER
1
.95
.9
.85
.8
.75
.7
.65
.6
.55
100
1000
10000
100000
FREQ IN Hz



HI FREQ. RIPPLE MULTIPLIER
251-450 VOLT
120 Hz
MULTIPLIER
1
.95
.9
.85
.8
.75
.7
.65
.6
.55
100
1000
10000
100000
FREQ IN Hz

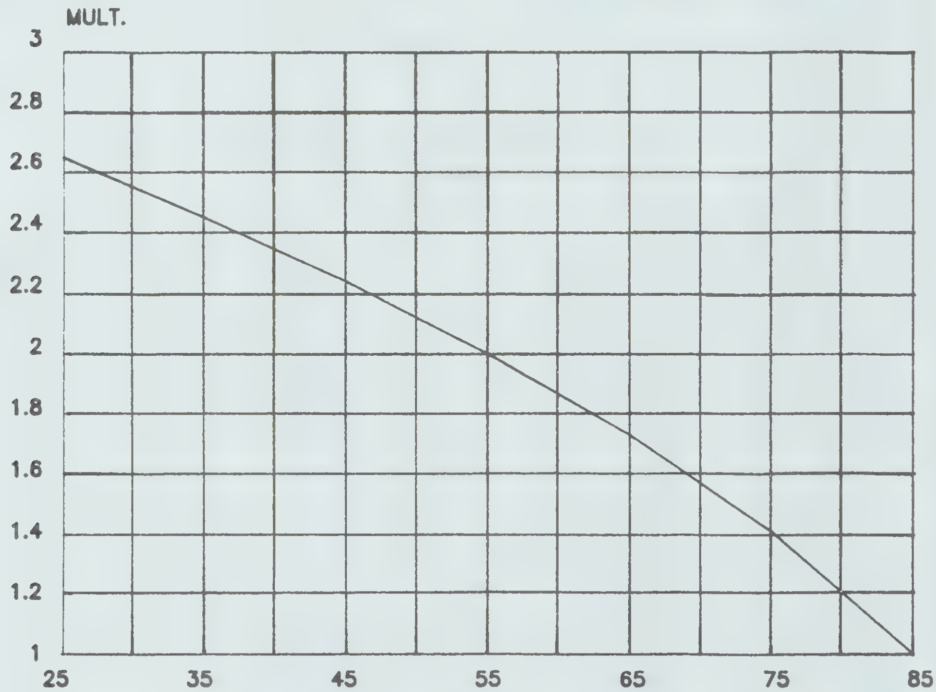
2.0 RIPPLE CURRENT.

All capacitors will withstand the RMS ripple current stated in the standard rating tables, specified at an ambient temperature of 85°C and a frequency of 120 Hz. Permissible ripple current at other temperatures, frequencies and with forced air can be calculated as indicated below. Where capacitors are operated at a temperature frequency and in forced air, all applicable multiplying factors should be used.

2.1 TYPICAL RIPPLE CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE.

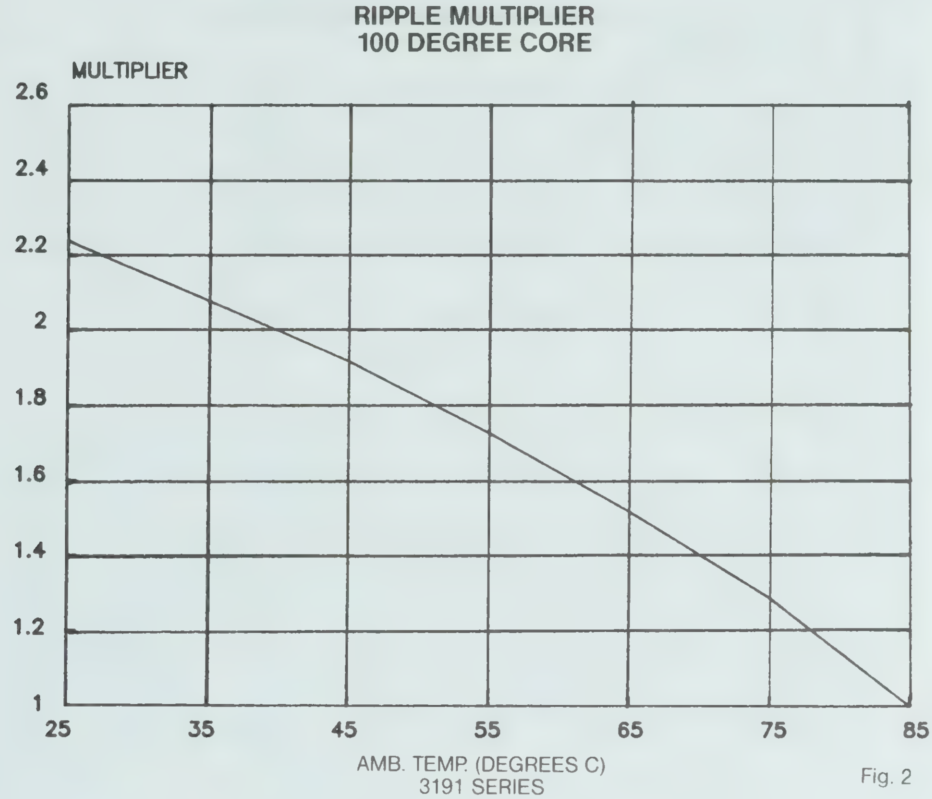
To determine the maximum allowable ripple current at ambient temperatures less than 85°C, find the ripple current multiplier from the appropriate curve (fig. 1, 2 or 3). The multiplier times the 85°C ripple current rating yields the maximum allowable ripple current at the subject temperature.

RIPPLE MULTIPLIER
95 DEGREE CORE



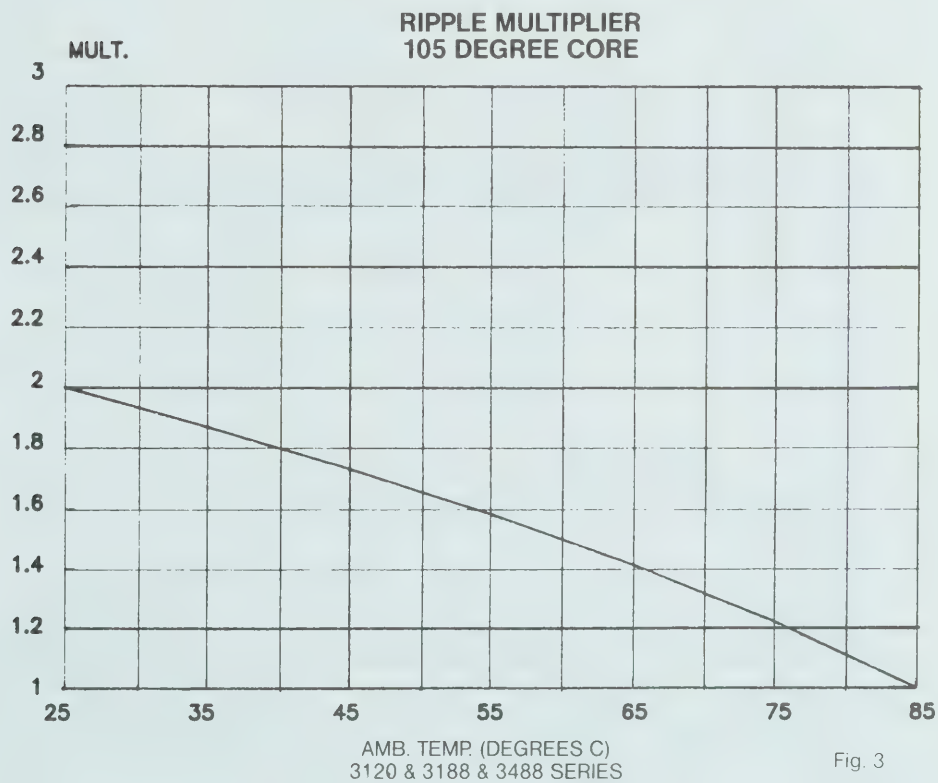
AMB. TEMP. (DEGREES C)
3186 SERIES
3487-3489

Fig. 1



RIPPLE MULTIPLIER
100 DEGREE CORE
MULTIPLIER
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
25
35
45
55
65
75
85
AMB. TEMP. (DEGREES C)
3191 SERIES

Fig. 2



RIPPLE MULTIPLIER
105 DEGREE CORE
MULT.
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
25
35
45
55
65
75
85
AMB. TEMP. (DEGREES C)
3120 & 3188 & 3488 SERIES

Fig. 3

Application Guidelines

Computer Grade & Snap-in

2.2 TYPICAL RIPPLE CURRENT AS A FUNCTION OF FREQUENCY.
To determine the maximum allowable ripple current at frequencies above 120 Hz to 100 KHz, find the ripple current multiplier from the appropriate curve (fig. 4, 5 or 6). The multiplier times the 120 Hz ripple current rating yields the maximum allowable ripple current at the subject frequency.

HI FREQ. ESR MULTIPLIER
0-75 VOLT

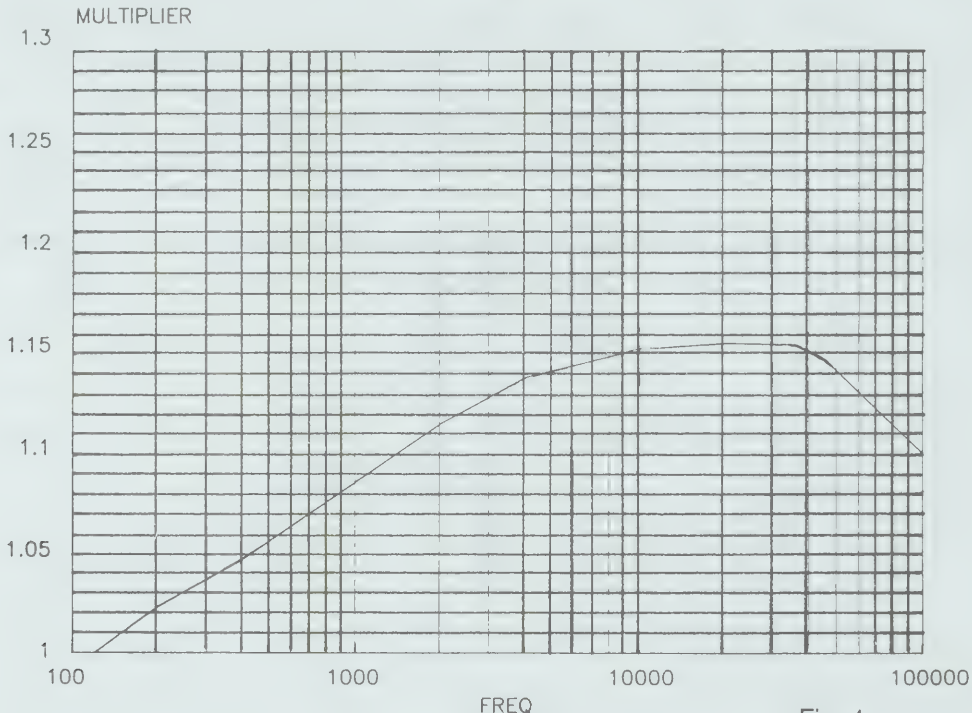


Fig. 4

HI FREQ. ESR MULTIPLIER
76-250 VOLT

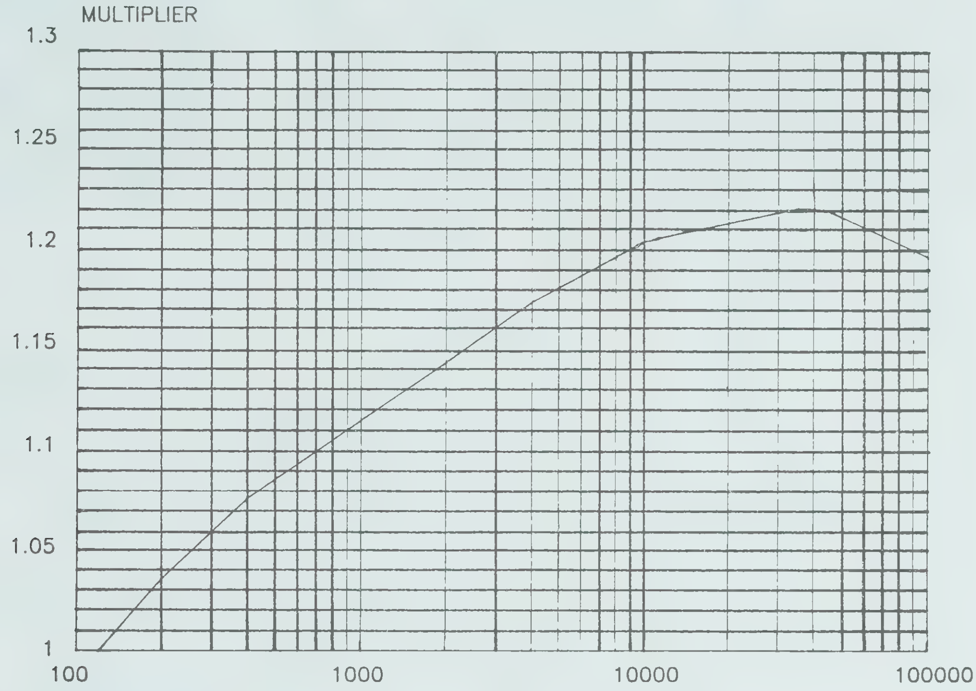


Fig. 5

HI FREQ. ESR MULTIPLIER
251-450 VOLT

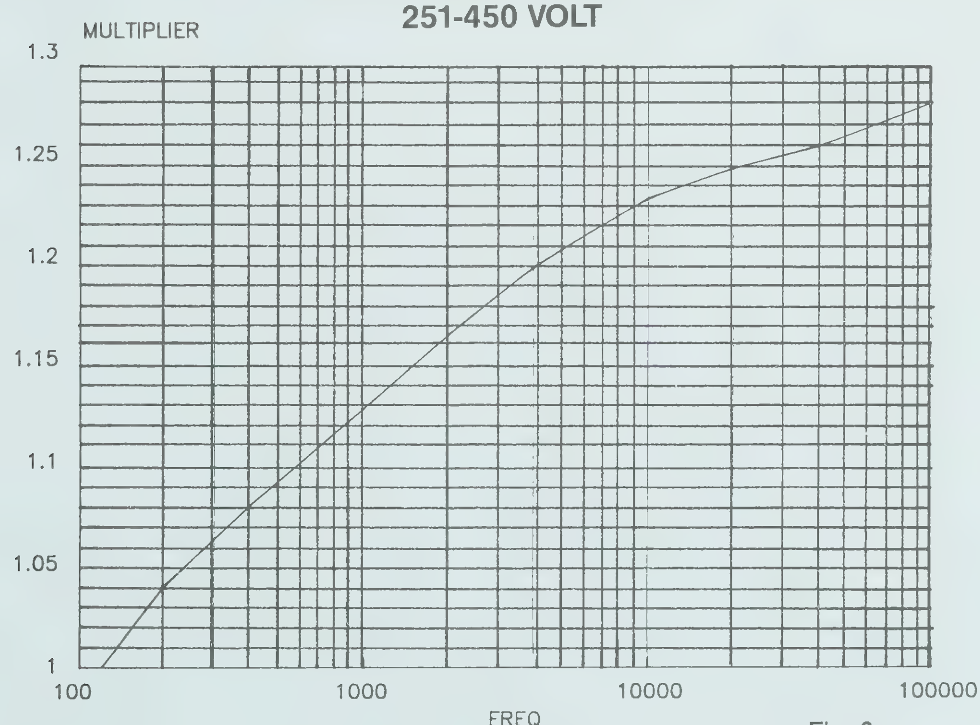


Fig. 6

2.3 TYPICAL RIPPLE CURRENT AS A FUNCTION OF FORCED AIR FLOW.

Thermal efficiency can be boosted by judicious use of forced air cooling in some applications. Occasionally a power-supply designer will calculate the proper capacitance value for the filter, then find that the ripple current requirements exceed the capability of the selected capacitor. The need for adding more capacitance in this situation can often be avoided if forced air is used to increase the ripple current capability of the capacitor. To determine the maximum allowable ripple current under a forced air application, find the ripple current multiplier from the appropriate curve (fig. 7). The multiplier times the still air ripple current rating yields the maximum allowable ripple current at the subject air flow. The thermal conductivity with respect to the air velocity is illustrated in figure 8.

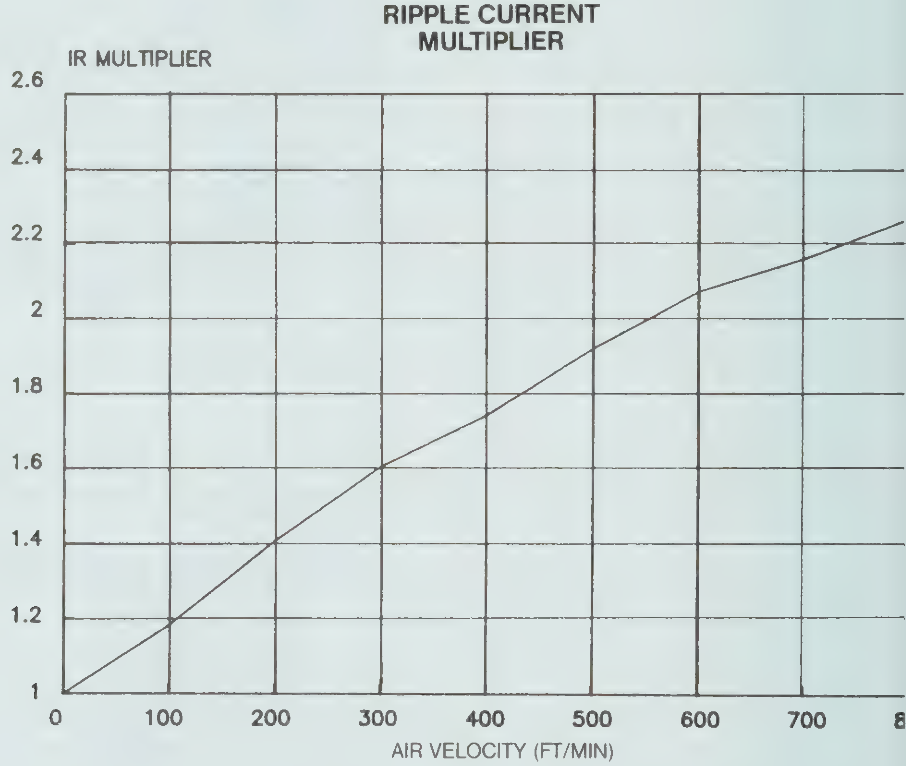


FIG. 7

THERMAL CONDUCTIVITY
(W/IN²/DEG C)

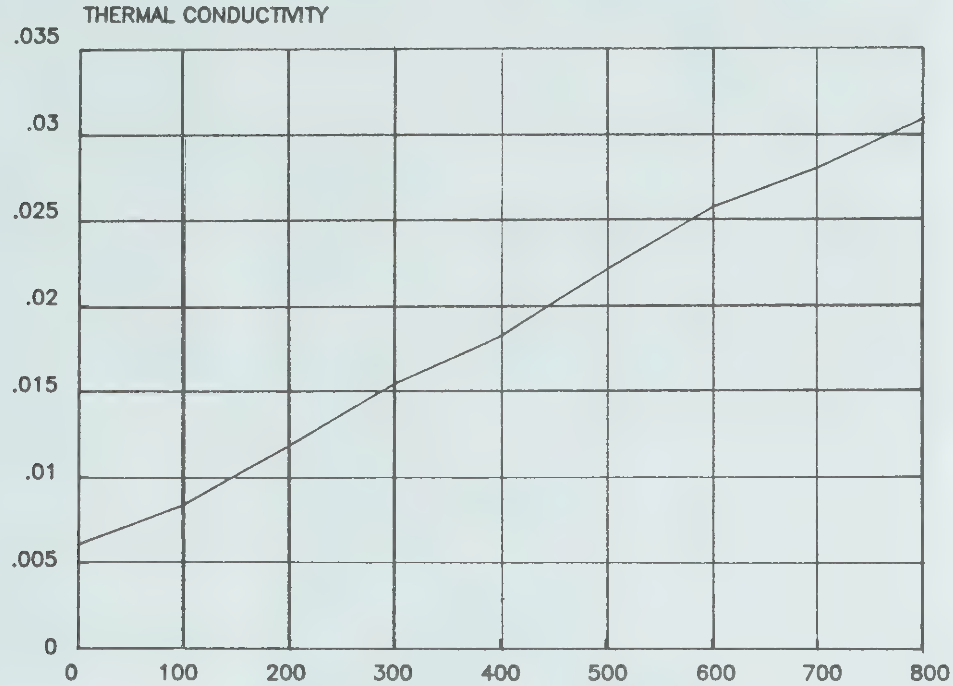


Fig. 8

3. TERMINAL HEAT RISE. To limit terminal heat rise, the 85°C ripple current should not exceed the following RMS values:
Standard Terminal: 30 amps
High-Current Terminal: 45 amps
When ripple currents greater than 10 amperes RMS are applied to these capacitors, the terminal screws should be torqued to a minimum of 20-inch-pounds (maximum, 25-inch-pounds) for standard terminals and 50-inch pounds (maximum, 60-inch-pounds) for high-current terminals to minimize I^2R losses at the terminals.

4. RIPPLE VOLTAGE AND VOLTAGE REVERSAL. The sum of the DC voltage and peak ripple voltage must not exceed the rated voltage of the capacitor.

To avoid polarity reversal on the capacitor, the peak AC voltage applied must not exceed the applied DC voltage. All Series can withstand a maximum voltage reversal of 1.5 volts for short periods of time as indicated, without any significant change in electrical characteristics.

5. INSULATION AND GROUNDING. These capacitors have an indeterminated resistance between the cathode terminal and the container. The container should be considered to be at the same potential as the cathode terminal with respect to ground. When a potential other than that of chassis ground is present on the cathode terminal, the container should be properly insulated.

5.1 INSULATING SLEEVE. These capacitors may be supplied with PVC insulation for 85°C ambient operation.

The insulation shall be tested in accordance with EIA specification RS-395 paragraph 2.19.

The typical insulation breakdown voltages measured between the cathode terminal or case and a 1″ metallic band wrapped around the insulated container are as follows, at a relative humidity of 45%, ambient temperature of 25°C, and breakdown current of 1000μA:

PVC	Insulation Thickness	.004″	.006″	.008″	.012″
	Breakdown Voltage (VAC)	1600	2000	2400	3200
MYLAR	Insulation Thickness	.0023″			
	Breakdown Voltage	17250			
LEXAN	Insulation Thickness	.020″			
	Breakdown Voltage	2100			

6. SAFETY VENT.
SERIES 3487, 3488, 3489
A unique vent is designed into the top of the aluminum can, so constructed that the end of the can will rupture and release dangerous internal pressure which could occur in the event of a circuit malfunction or polarity reversal.
SERIES 3120, 3186, 3188, 3191:
These capacitors are designed with a safety device incorporated in the header. This device prevents case rupture or cover damage in event of excess pressure build-up due to improper operation.

Vent Test: A reverse DC voltage shall be applied to the capacitor to cause a reverse current flow of 10 amperes. The capacitor should be securely mounted to a surface by wrap-around clamp during this test. The vent should operate before an explosion or the expulsion of any capacitor material occurs. A capacitor which does not vent within 20 minutes is considered to have passed the vent test.

7. MOUNTING
SERIES 3186, 3188, 3191: Vertical mounting of the capacitor with the terminals up is recommended: however, horizontal mounting with the pressure relief vent up is acceptable. Vertical mounting with the terminals down and horizontal mounting with the pressure relief vent down are not recommended, since this could impair the operation of the safety vent.
SERIES 3487, 3488, 3489, 3120. These capacitors may be mounted in any plane.

8. CLEANING SOLVENT WARNING AND DISCLAIMER. Industry standards such as EIA RS-395 and Military Specification MIL-C-39018 caution against the use of halogenated hydrocarbon solvents in cleaning boards containing aluminum electrolytic capacitors. The probability of failures in capacitors cleaned by halogenated hydrocarbon solvents is sufficient for Philips Components to disclaim any warranties, specific or implied, to our product if our capacitors are subjected in any manner or extent to these solvents.

Examples of these solvents are Freon TF®, Freon TMC®, carbon tetrachloride, chloroform, trichloroethylene, trichloroethane, methylene chloride and MEK. Recommended solvents are those free of halogens or halogen groups, such as ethyl alcohol, butyl alcohol, methyl alcohol, propyl alcohol, and water.

If halogenated hydrocarbon solvents must be used, the following alternatives exist:

a. The electrolytic capacitors should be inserted into the boards after the cleaning process has been completed.

b. On special order, Philips Components can supply snap-in designs to meet solvents requirements.

SAFETY

WITH CAPACITORS HAVING A HIGH WATT-SECOND CAPABILITY IT IS IMPORTANT THAT SUITABLE PRECAUTIONS BE OBSERVED IN THE TESTING AND APPLICATION OF THESE DEVICES. BLEEDER RESISTORS AND OTHER DISCHARGE CIRCUITRY SHOULD BE USED TO PROTECT SERVICEMEN AND USERS. WHEN USED IN LARGE BANKS, THE MECHANICAL STRUCTURE MUST BE DESIGNED SO AS TO WITHSTAND THE LARGE CURRENTS THAT MAY OCCUR IN THE EVENT OF A CAPACITOR SHORT CIRCUIT. THE MECHANICAL STRUCTURE SHOULD ALSO BE CONSTRUCTED SO THAT IT WILL CONTAIN THE CAPACITORS IF A CAPACITOR EXPLOSION SHOULD OCCUR.

MISAPPLICATIONS, SUCH AS EXCEEDING DESIGN LIMITS OR APPLYING REVERSE VOLTAGE TO POLAR UNITS, MAY RESULT IN DESTRUCTION OR EXPLOSION OF CAPACITORS.

PRECAUTIONS IN CASE OF VENT OPERATION.

OPERATION OF THE VENT STRUCTURE INVOLVES EXPULSION OF HOT GASES AND/OR LIQUIDS UNDER HIGH PRESSURE. CONTACT WITH THIS MATERIAL COULD CAUSE PERSONAL INJURY OR PROPERTY DAMAGE AND THEREFORE SHOULD BE AVOIDED.

GENERAL

In the event that application requirements exceed the parameters of a particular Series, it is often possible to use a standard capacitor, providing certain "trade-offs" are acceptable. It is also possible that special designs and manufacturing techniques not normally included can be applied to meet a special situation. These include the following:

- Higher Vibration Limits
- Higher Ripple Current
- Lower ESR
- Non-Polar Construction
- Solder-Lug Terminals
- Metric Threaded Terminals
- Special Capacitance Tolerance
- Special Marking and Labeling
- Additional Case Sizes

More specific device parameters can be obtained on request, these include:

- ESR at any Frequency (to 100kHz)
- Ripple Current Rating at any Frequency (to 100kHz)
- Impedance and ESR vs. Frequency Plots
- Inductance

1. CAPACITOR LIFE PREDICTION GUIDELINES

The following equations and tables can be used to predict the life of aluminum electrolytic capacitors at derated voltages and temperatures. Failures are defined as parameter drift beyond the limits outlined in the life test section of the Performance Specifications.

Based on DC aluminum electrolytic capacitor tests, the inherent relationships between temperature, voltage and life were established. A failure rate for each product was established from testing at maximum rated conditions. From this failure rate a base lifetime was established.

The expected life for each product type is determinted by computing the capacitor hot-spot temperature [equation (1) and the ratio of use voltage to rated voltage. From this, the base life multiplier can be found in the appropriate table. The multiplier times the base life (found in Table 1) yields the expected life.

The computation of expected life assumes a constant or decreasing failure rate and that the wearout portion of the product life has not been reached. The expected life is the statistical time required to generate one failure in 25 units based on a 60% confidence level.

Multipliers resulting in expected lifetimes in excess of 10 years may not be valid due to secondary failure modes not considered in the construction of these tables.

CALCULATION OF CORE TEMPERATURE

$$\text{(1) Core Temp}^{*} = \text{Ambient Temp} + \frac{I^2 \times \text{E.S.R.}}{K \times \text{Area}}$$

$$K = .006 \frac{\dfrac{\text{WATTS}}{\text{Area/sq. inch}}}{{}^{\circ}\text{C Temp Rise}}$$

AREA = Surface Area of Can =

$$\pi \times D_{IA} \times \left(L_E + \left(\frac{D_{IA}}{2}\right)\right)$$

I = Ripple Current (Amps)
AMB = Ambient Temperature (°C)
ESR = Equivalent Series Resistance (ohms)

*Based on free convection in still air. For values of K in forced air see Application guidelines sec 2.3.

TABLE 1
TABLE BASE LIFE

TYPE	LOAD* LIFE HOURS	AMBIENT TEMP. °C	DESIGN CORE TEMP. °C	LIFE MULTIPLIER TABLE
3120	3000	85	105	2
3186	1000	85	95	1
3188	2000	85	105	3
3191	1500	85	100	4
3487	1000	85	95	1
3488	2000	85	105	3
3489	1000	85	95	1

*Load Life=Max. rated amb. temp., voltage and ripple current.

LIFE MULTIPLIER—TABLE 1

CORE TEMP.	% RATED VOLTAGE 75	80	85	90	95	100
95	2.6	2.2	1.8	1.5	1.2	1.0
94	2.7	2.2	1.8	1.6	1.3	1.1
93	2.9	2.4	2.0	1.6	1.3	1.2
92	3.3	2.8	2.4	1.9	1.5	1.2
91	3.6	2.9	2.4	2.0	1.6	1.3
90	3.8	3.2	2.6	2.2	1.8	1.4
89	4.2	3.4	2.8	2.3	1.9	1.5
88	4.2	3.5	2.9	2.4	1.9	1.6
87	4.6	3.9	3.2	2.6	2.1	1.7
86	5.0	4.2	3.4	2.9	2.4	1.9
85	5.3	4.4	3.6	3.0	2.4	2.0
84	5.8	4.9	4.0	3.2	2.6	2.1
83	6.2	5.2	4.2	3.5	2.8	2.3
82	6.6	5.5	4.4	3.7	3.0	2.5
81	7.3	6.1	5.0	4.1	3.3	2.6
80	7.9	6.5	5.4	4.4	3.5	2.8
79	8.3	6.8	5.6	4.5	3.7	3.0
78	9.1	7.5	6.1	5.0	4.0	3.3
77	9.6	7.9	6.4	5.3	4.2	3.5
76	10.5	8.6	7.1	5.7	4.7	3.7
75	11.3	9.2	7.5	6.1	5.0	4.0
74	12.2	10.0	8.1	6.6	5.3	4.3
73	12.9	10.6	8.6	7.0	5.6	4.6
72	14.1	11.4	9.4	7.6	6.1	4.9
71	15.1	12.4	10.0	8.1	6.6	5.3
70	16.3	13.3	10.6	8.8	7.1	5.7
69	17.3	14.2	11.5	9.3	7.5	6.1
68	18.8	15.4	12.4	10.1	8.1	6.5
67	20.0	16.3	13.2	10.7	8.6	7.0
66	21.7	17.6	14.3	11.6	9.3	7.5
65	23.3	18.9	15.3	12.4	10.0	8.0
64	25.2	20.4	16.5	13.3	10.7	8.6
63	27.0	21.9	17.6	14.2	11.4	9.2
62	29.1	23.5	19.0	15.3	12.4	9.8
61	31.2	25.3	20.4	16.4	13.2	10.6
60	33.4	26.9	21.7	17.5	14.1	11.3
59	35.9	29.0	23.3	18.7	15.1	12.1
58	38.8	31.3	25.2	20.3	16.2	13.0
57	41.5	33.5	26.9	21.6	17.3	13.9
56	44.7	36.0	28.9	23.2	18.6	14.9
55	48.0	38.6	31.0	24.9	19.9	16.0
54	51.5	41.4	33.4	26.6	21.3	17.2
53	55.6	44.6	35.8	28.7	23.0	18.4
52	59.6	47.9	38.4	30.7	24.6	19.7
51	64.1	51.3	41.1	32.9	26.4	21.1
50	68.8	55.2	44.2	35.4	28.3	22.6
49	74.0	59.2	47.4	37.9	30.3	24.2
48	79.6	63.7	51.0	40.7	32.5	26.0
47	85.6	68.3	54.6	43.7	34.9	27.9
46	91.8	73.3	58.5	46.8	37.4	29.9
45	98.5	78.6	62.8	50.2	40.0	32.0
44	105.9	84.4	67.3	53.8	42.9	34.3
43	113.9	90.8	72.4	57.7	46.1	36.8
42	122.3	97.4	77.6	61.9	49.4	39.4
41	131.3	104.5	83.3	66.3	52.9	42.2
40	141.1	112.2	89.3	71.2	56.8	45.3
39	151.3	120.4	95.7	76.3	60.8	48.5
38	162.7	129.2	102.8	81.9	65.2	52.0
37	174.7	138.7	110.3	87.8	69.9	55.7
36	187.6	148.9	118.3	94.1	75.0	59.7
35	201.4	159.7	126.8	100.9	80.3	64.0
34	216.2	171.4	136.1	108.2	86.1	68.6
33	232.5	184.2	146.1	116.1	92.4	73.5
32	249.4	197.5	156.7	124.4	99.0	78.8
31	267.9	212.0	168.1	133.5	106.1	84.5
30	287.5	227.4	180.2	143.1	113.8	90.5
29	308.6	244.0	193.3	153.4	121.9	97.0
28	331.3	261.8	207.3	164.5	130.7	104.0
27	355.6	280.8	222.3	176.3	140.1	111.4
26	382.0	301.6	238.6	189.2	150.3	119.4
25	409.9	323.4	255.8	202.8	161.0	128.0

Aluminum Electrolytic Capacitors
TECHNICAL NOTES

LIFE MULTIPLIER—TABLE 2

CORE TEMP.	% RATED VOLTAGE 75	80	85	90	95	100
105	1.80	1.60	1.40	1.30	1.10	1.00
104	1.75	1.57	1.48	1.29	1.11	1.01
103	1.80	1.63	1.46	1.29	1.11	1.03
102	1.85	1.69	1.45	1.29	1.12	1.04
101	1.89	1.66	1.51	1.36	1.21	1.06
100	1.93	1.72	1.58	1.36	1.22	1.07
99	1.98	1.77	1.57	1.43	1.23	1.09
98	2.08	1.82	1.63	1.43	1.30	1.11
97	2.01	1.83	1.59	1.42	1.24	1.12
96	2.11	1.93	1.71	1.48	1.31	1.14
95	2.15	1.89	1.68	1.47	1.31	1.15
94	2.24	1.99	1.78	1.58	1.38	1.17
93	2.28	2.04	1.81	1.57	1.38	1.19
92	2.32	2.05	1.83	1.61	1.38	1.21
91	2.40	2.11	1.86	1.64	1.43	1.22
90	2.37	2.09	1.86	1.63	1.43	1.24
89	2.48	2.18	1.93	1.67	1.44	1.26
88	2.49	2.21	1.93	1.69	1.48	1.28
87	2.56	2.23	1.98	1.72	1.49	1.30
86	2.60	2.29	2.02	1.74	1.53	1.31
85	2.67	2.35	2.06	1.80	1.57	1.33
84	2.86	2.52	2.20	1.91	1.66	1.43
83	3.09	2.69	2.35	2.04	1.76	1.53
82	3.34	2.92	2.55	2.21	1.90	1.64
81	3.63	3.18	2.75	2.38	2.07	1.76
80	3.91	3.41	2.96	2.56	2.20	1.89
79	4.21	3.68	3.20	2.75	2.36	2.02
78	4.53	3.94	3.42	2.94	2.53	2.17
77	4.86	4.23	3.68	3.15	2.71	2.32
76	5.28	4.59	3.98	3.43	2.93	2.49
75	5.69	4.95	4.26	3.66	3.13	2.67
74	6.10	5.28	4.57	3.92	3.35	2.86
73	6.59	5.69	4.91	4.20	3.61	3.06
72	7.08	6.11	5.25	4.49	3.85	3.28
71	7.66	6.61	5.67	4.86	4.14	3.52
70	8.24	7.11	6.10	5.22	4.44	3.77
69	8.88	7.63	6.54	5.58	4.76	4.04
68	9.54	8.19	7.03	6.00	5.10	4.33
67	10.3	8.84	7.57	6.44	5.49	4.64
66	11.1	9.53	8.14	6.92	5.90	4.98
65	11.9	10.2	8.73	7.42	6.30	5.33
64	12.9	11.0	9.40	8.04	6.76	5.72
63	13.9	11.9	10.1	8.57	7.24	6.13
62	14.9	12.7	10.8	9.20	7.78	6.57
61	16.1	13.7	11.7	9.87	8.35	7.04
60	17.3	14.8	12.5	10.6	8.95	7.54
59	18.7	15.9	13.5	11.4	9.59	8.08
58	20.1	17.1	14.4	12.2	10.3	8.66
57	21.7	18.3	15.5	13.1	11.0	9.29
56	23.3	19.7	16.6	14.0	11.8	9.95
55	25.1	21.2	17.9	15.1	12.7	10.7
54	27.1	22.8	19.2	16.2	13.6	11.4
53	29.1	24.5	20.7	17.4	14.6	12.3
52	31.3	26.4	22.2	18.6	15.6	13.1
51	33.7	28.4	23.8	20.0	16.8	14.1
50	36.3	30.5	25.6	21.5	18.0	15.1
49	39.1	32.8	27.5	23.1	19.3	16.2
48	42.1	35.3	29.6	24.7	20.7	17.3
47	45.3	37.9	31.7	26.5	22.2	18.6
46	48.7	40.7	34.1	28.5	23.8	19.9
45	52.5	43.8	36.6	30.6	25.5	21.3
44	56.4	47.1	39.3	32.8	27.4	22.9
43	60.7	50.6	42.2	35.2	29.4	24.5
42	65.3	54.4	45.3	37.7	31.5	26.3
41	70.3	58.4	48.6	40.5	33.8	28.1
40	75.6	62.8	52.2	43.4	36.2	30.2
39	81.4	67.5	56.1	46.6	38.8	32.3
38	87.5	72.5	60.2	50.0	41.6	34.7
37	94.2	78.0	64.6	53.7	44.6	37.1
36	101.3	83.0	69.4	57.6	47.9	39.8
35	109.0	90.0	74.5	61.8	51.3	42.7
34	117.2	96.7	80.0	66.3	55.0	45.7
33	126.0	103.9	85.9	71.1	59.0	49.0
32	135.5	111.6	92.2	76.3	63.2	52.5
31	145.7	119.9	99.0	81.9	67.8	56.3
30	156.7	128.8	106.3	87.8	72.7	60.3
29	168.5	138.4	114.0	94.2	78.0	64.7
28	181.1	148.6	122.4	101.0	83.6	69.3
27	194.7	159.7	131.4	108.4	89.7	74.3
26	209.3	171.5	141.0	116.3	96.1	79.6
25	225.1	184.2	151.3	124.7	103.0	85.3

LIFE MULTIPLIER—TABLE 3

CORE TEMP.	% RATED VOLTAGE 75	80	85	90	95	100
105	1.80	1.60	1.40	1.30	1.10	1.00
104	1.79	1.60	1.51	1.32	1.13	1.04
103	1.88	1.70	1.52	1.34	1.16	1.07
102	1.96	1.79	1.54	1.37	1.19	1.11
101	2.05	1.81	1.64	1.48	1.31	1.15
100	2.14	1.90	1.74	1.51	1.35	1.19
99	2.23	2.00	1.77	1.62	1.39	1.23
98	2.40	2.10	1.87	1.65	1.50	1.27
97	2.36	2.15	1.88	1.67	1.46	1.32
96	2.53	2.32	2.05	1.78	1.57	1.37
95	2.64	2.31	2.06	1.80	1.61	1.41
94	2.80	2.48	2.23	1.97	1.72	1.46
93	2.91	2.61	2.30	2.00	1.76	1.52
92	3.02	2.67	2.38	2.09	1.80	1.57
91	3.19	2.80	2.46	2.18	1.90	1.62
90	3.21	2.84	2.52	2.21	1.94	1.68
89	3.43	3.02	2.66	2.30	2.00	1.74
88	3.51	3.12	2.73	2.39	2.09	1.80
87	3.69	3.22	2.85	2.47	2.15	1.87
86	3.82	3.37	2.97	2.56	2.25	1.93
85	4.00	3.52	3.09	2.70	2.35	2.00
84	4.29	3.77	3.30	2.87	2.49	2.14
83	4.64	4.04	3.53	3.06	2.64	2.30
82	5.01	4.37	3.82	3.31	2.84	2.46
81	5.45	4.77	4.13	3.58	3.11	2.64
80	5.87	5.11	4.43	3.84	3.29	2.83
79	6.32	5.52	4.80	4.13	3.54	3.03
78	6.79	5.91	5.12	4.42	3.79	3.25
77	7.30	6.34	5.51	4.73	4.06	3.48
76	7.92	6.88	5.97	5.14	4.40	3.73
75	8.54	7.42	6.39	5.48	4.70	4.00
74	9.15	7.92	6.86	5.88	5.02	4.29
73	9.88	8.54	7.36	6.30	5.41	4.59
72	10.6	9.16	7.87	6.74	5.77	4.92
71	11.5	9.91	8.50	7.29	6.20	5.28
7	12.4	10.7	9.15	7.82	6.66	5.66
69	13.3	11.4	9.81	8.38	7.14	6.06
68	14.3	12.3	10.5	8.99	7.65	6.50
67	15.5	13.3	11.4	9.66	8.23	6.96
66	16.7	14.3	12.2	10.4	8.85	7.46
65	17.9	15.3	13.1	11.1	9.45	8.00
64	19.4	16.6	14.1	12.1	10.1	8.57
63	20.8	17.8	15.1	12.8	10.9	9.19
62	22.4	19.1	16.2	13.8	11.7	9.85
61	24.2	20.6	17.5	14.8	12.5	10.6
6	26.0	22.1	18.8	15.9	13.4	11.3
59	28.1	23.8	20.2	17.1	14.4	12.1
58	30.2	25.6	21.7	18.3	15.4	13.0
57	32.5	27.5	23.3	19.6	16.6	13.9
56	35.0	29.6	25.0	21.1	17.7	14.9
55	37.7	31.8	26.9	22.7	19.1	16.0
54	40.6	34.3	28.9	24.3	20.4	17.1
53	43.7	36.8	31.0	26.0	21.9	18.4
52	47.0	39.5	33.3	27.9	23.5	19.7
51	50.6	42.6	35.7	30.0	25.2	21.1
50	54.4	45.7	38.4	32.2	27.0	22.6
49	58.7	49.2	41.3	34.6	29.0	24.3
48	63.2	52.9	44.3	37.1	31.1	26.0
47	67.9	56.9	47.6	39.8	33.3	27.9
46	73.1	61.1	51.1	42.7	35.7	29.9
45	78.7	65.7	54.9	45.9	38.3	32.0
44	84.6	70.6	58.9	49.2	41.1	34.3
43	91.1	75.9	63.2	52.8	44.0	36.8
42	98.0	81.6	68.0	56.6	47.2	39.4
41	105.5	87.7	73.0	60.7	50.6	42.2
40	113.4	94.2	78.3	65.2	54.3	45.3
39	122.1	101.3	84.1	69.9	58.2	48.5
38	131.3	108.8	90.3	75.0	62.4	52.0
37	141.3	117.0	97.0	80.5	67.0	55.7
36	152.0	125.7	104.1	86.4	71.8	59.7
35	163.4	135.0	111.8	92.7	77.0	64.0
34	175.8	145.1	120.0	99.4	82.5	68.6
33	189.0	155.8	128.8	106.7	88.5	73.5
32	203.3	167.4	138.3	114.4	94.9	78.8
31	218.6	179.9	148.5	122.8	101.7	84.4
30	235.1	193.3	159.4	131.7	109.1	90.5
29	252.7	207.6	171.0	141.3	117.0	97.0
28	271.7	223.0	183.6	151.6	125.4	104.0
27	292.1	239.5	197.1	162.6	134.5	111.4
26	314.0	257.2	211.5	174.4	144.2	119.4
25	337.6	276.3	227.0	187.1	154.6	128.0

Aluminum Electrolytic Capacitors
TECHNICAL NOTES

LIFE MULTIPLIER—TABLE 4

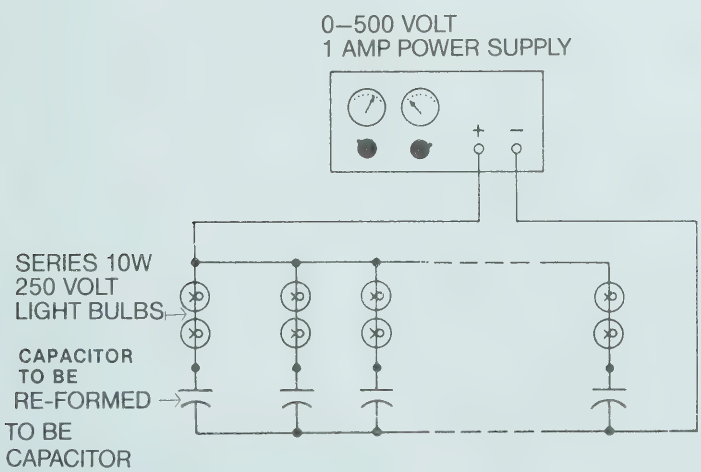
CORE TEMP.	% RATED VOLTAGE 75	80	85	90	95	100
100	2.50	2.10	1.80	1.50	1.20	1.00
99	2.54	2.16	1.79	1.51	1.22	1.04
98	2.59	2.23	1.88	1.52	1.25	1.07
97	2.96	2.50	2.03	1.66	1.39	1.11
96	3.00	2.56	2.12	1.77	1.41	1.15
95	3.14	2.63	2.21	1.78	1.53	1.19
94	3.28	2.79	2.30	1.89	1.56	1.23
93	3.22	2.70	2.25	1.87	1.50	1.27
92	3.45	2.86	2.35	1.98	1.61	1.32
91	3.59	3.02	2.52	2.08	1.73	1.37
90	3.64	3.03	2.56	2.09	1.68	1.41
89	3.93	3.26	2.73	2.20	1.80	1.46
88	3.98	3.35	2.78	2.27	1.83	1.52
87	4.16	3.44	2.84	2.35	1.93	1.57
86	4.29	3.54	2.96	2.44	1.97	1.62
85	5.33	4.40	3.67	3.00	2.40	2.00
84	5.76	4.76	3.95	3.22	2.61	2.14
83	6.28	5.20	4.26	3.51	2.84	2.30
82	6.65	5.52	4.53	3.73	2.99	2.46
81	7.31	6.02	4.94	4.06	3.32	2.64
80	7.88	6.46	5.32	4.31	3.50	2.83
79	8.30	6.85	5.60	4.55	3.69	3.03
78	9.02	7.43	6.10	4.97	4.04	3.25
77	9.66	7.95	6.50	5.26	4.27	3.48
76	10.5	8.66	7.06	5.73	4.67	3.73
75	11.2	9.18	7.48	6.10	4.92	4.00
74	12.1	9.96	8.11	6.60	5.34	4.29
73	13.0	10.6	8.66	7.02	5.71	4.59
72	14.1	11.5	9.32	7.55	6.11	4.92
71	15.0	12.3	9.97	8.08	6.52	5.28
70	16.1	13.2	10.7	8.65	7.02	5.66
69	17.5	14.2	11.5	9.32	7.56	6.06
68	18.7	15.3	12.3	10.0	8.06	6.50
67	20.2	16.5	13.3	10.7	8.66	6.96
66	21.7	17.7	14.3	11.6	9.28	7.46
65	23.3	12.5	15.3	12.3	9.94	8.00
64	25.0	20.3	16.4	13.2	10.6	8.57
63	26.9	21.8	17.6	14.2	11.4	9.19
62	29.0	23.5	18.9	15.3	12.3	9.85
61	31.2	25.2	20.3	16.4	13.2	10.6
60	33.6	27.1	21.9	17.6	14.1	11.3
59	36.1	29.1	23.5	18.9	15.1	12.1
58	38.8	31.2	25.2	20.2	16.2	13.0
57	41.7	33.5	27.0	21.7	17.4	13.9
56	44.8	36.0	29.0	23.2	18.6	14.9
55	48.1	38.7	31.1	24.9	20.0	16.0
54	51.6	41.5	33.3	26.7	21.4	17.1
53	55.6	44.6	35.8	28.7	23.0	18.4
52	59.6	47.8	38.3	30.7	24.6	19.7
51	64.2	51.5	41.2	33.0	26.4	21.1
50	68.8	55.2	44.2	35.3	28.3	22.6
49	74.0	59.2	47.4	37.9	30.3	24.3
48	79.6	63.6	50.8	40.7	32.5	26.0
47	85.5	68.3	54.6	43.6	34.9	27.9
46	91.9	73.4	58.6	46.8	37.4	29.9
45	98.6	78.7	62.9	50.2	40.0	32.0
44	106.0	84.5	67.5	53.8	43.0	34.3
43	113.8	90.7	72.3	57.7	46.0	36.0
42	122.2	97.3	77.5	61.9	49.4	39.4
41	131.4	104.6	83.3	66.4	52.9	42.2
40	141.0	112.1	89.3	71.1	56.7	45.3
39	151.5	120.4	95.9	76.4	60.9	48.5
38	162.6	129.2	102.8	81.8	65.2	52.0
37	174.8	138.8	110.4	87.8	69.9	55.7
36	187.7	149.0	118.4	94.2	75.0	59.7
35	201.5	159.8	126.9	100.9	80.4	64.0
34	216.3	171.5	136.1	108.2	86.1	68.6
33	232.3	184.0	146.0	116.1	92.3	73.5
32	249.4	197.5	156.7	124.4	99.0	78.8
31	267.9	212.0	168.1	133.5	106.1	84.4
30	287.5	227.4	180.3	143.1	113.8	90.5
29	308.7	244.1	193.3	153.4	122.0	97.0
28	296.1	233.9	185.3	147.0	116.8	104.0
27	355.7	280.9	222.4	176.4	140.1	111.4
26	381.8	301.4	238.5	189.1	150.1	119.4
25	409.9	323.4	255.8	202.8	161.0	128.0

2. FIELD RE-FORM PROCEDURE

DC aluminum electrolytic capacitors require reforming when the leakage current exceeds the value calculated from the leakage current formulas in paragraph 3 below. The procedure for reforming in the field is as follows:

1. Preheat capacitors to 85°C ±5°C for 4 hours ±.5 hour.
2. Remove capacitors from oven and apply 110% rated voltage in a room temperature ambient (25°C ±3°C) as per the diagram below. Remove and discard any units that are shorted or appear to draw a constant or increasing amount of current.
3. Remove units from the re-form set-up after the *average* unit current drawn from the power supply is ¼ of the leakage requirement for the unit type involved.
4. Condition units for 24 hours ±5 hours in a room-temperature ambient with no voltage applied. Then measure leakage current as outlined in Performance Specifications paragraph 6. Repeat steps 1 through 4 for units that do not meet this limit. Discard any units that have ruptured vent plugs or have evidence of leaking electrolyte.

   When units are re-formed by this procedure, they will have a shelf life of approximately one year, provided the storage ambient does not exceed 40°C.



3. CAPACITOR SHELF-CHARACTERISTICS

The graphs on the next page can be used to predict the shelf life of aluminum electrolytic capacitors stored in various ambient temperatures. The Specification Limit Line on the left of the graph indicates the length of time, at various temperatures for which the capacitors are expected to meet the leakage current limits calculated from the formulas shown below. The Practical Limit Line on the right of the graph defines the length of storage for which a user should expect acceptable performance from the capacitor in normal applications.

Capacitors that are to be used at operating temperatures which are at least 25°C less than the maximum operating temperature and have been in storage for a period longer than the Practical Limit should have their leakage current checked. Any unit whose leakage current exceeds the value calculated from the formulas shown below should be re-formed.

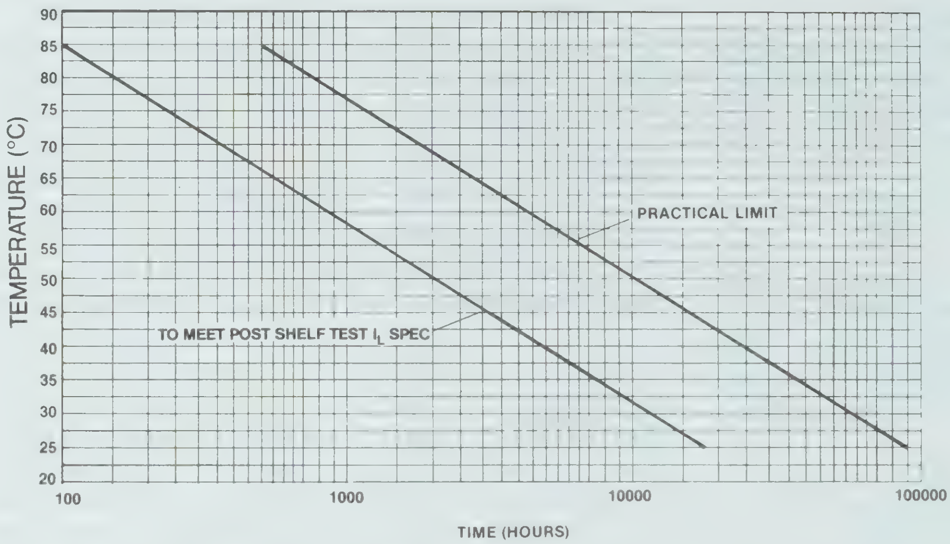
Capacitors that draw a constant or increasing amount of leakage should also be re-formed.

Leakage current after pre-conditioning or re-form is measured after five minutes of voltage application. The voltage is applied to the capacitor through a series resistor with a value such that the rated voltage will appear on the capacitor terminals within one minute.

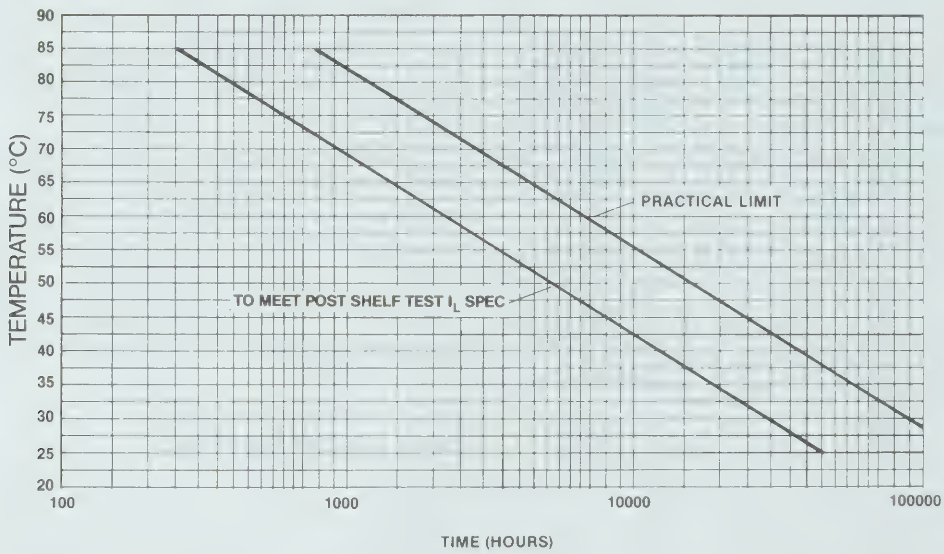
TABLE 4
Leakage Current Formulas

TIME SERIES	PRE-CONDITIONING EQUATION (MINUTES)	EQUATION I-MA	MAX. VALUE (MA)
3487 3489	30 30	$.006\sqrt{CV}$	6
3488 (CV ≤ 250,000) (CV > 250,000)	30 30	6×10^{-6} CV $.003\sqrt{CV}$	4 4
3120 (6–100V) (101–300V)	30 30	$.001\sqrt{CV}$ $.003\sqrt{CV}$	N/A N/A
3186	30	$.006\sqrt{CV}$	6
3188 (CV ≤ 250,000) (CV > 250,000)	30 30	6×10^{-6} CV $.003\sqrt{CV}$	4 4
3191	15	$.0015\sqrt{CV}$	N/A

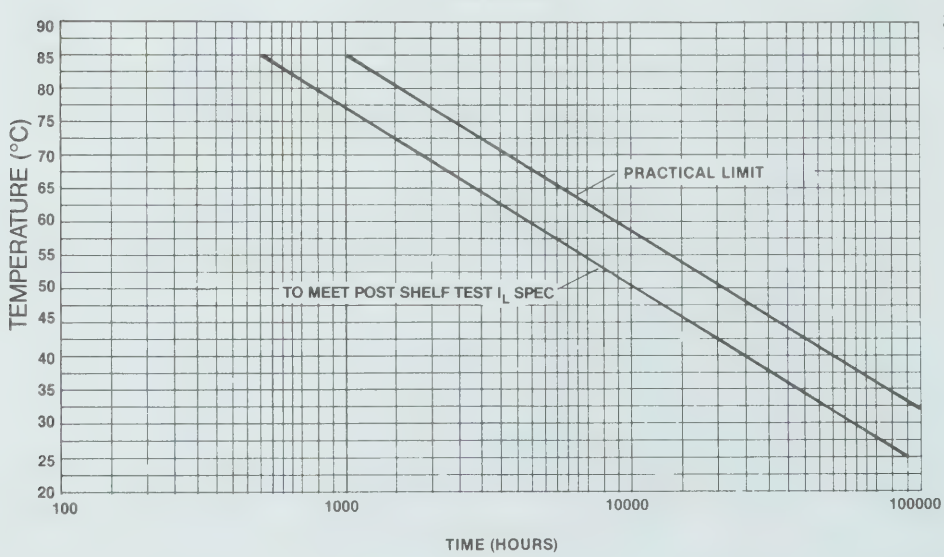
Aluminum Electrolytic Capacitors
TECHNICAL NOTES



3186, 3191 3487, 3489
SHELF CHARACTERISTICS



3188, 3488
SHELF CHARACTERISTICS



3120
SHELF CHARACTERISTICS

Aluminum Electrolytic Capacitors

Physical Specifications—Can-Style

DIMENSIONS

Case Code*	UNINSULATED CASE DIMENSIONS					
	Dimensions in Inches			Dimensions in Millimeters		
	D	L	S	D	L	S
BA	1.375	2.125	.500	34.92	53.97	12.70
BB	1.375	2.625	.500	34.92	66.67	12.70
BC	1.375	3.125	.500	34.92	79.37	12.70
BD	1.375	3.625	.500	34.92	92.07	12.70
BE	1.375	4.125	.500	34.92	104.77	12.70
BF	1.375	4.625	.500	34.92	117.47	12.70
BG	1.375	5.125	.500	34.92	130.17	12.70
BH	1.375	5.625	.500	34.92	142.87	12.70
DA	1.750	2.125	.750	44.45	53.97	19.05
DB	1.750	2.625	.750	44.45	66.67	19.05
DC	1.750	3.125	.750	44.45	79.37	19.05
DD	1.750	3.625	.750	44.45	92.07	19.05
DE	1.750	4.125	.750	44.45	104.77	19.05
DF	1.750	4.625	.750	44.45	117.47	19.05
DG	1.750	5.125	.750	44.45	130.17	19.05
DH	1.750	5.625	.750	44.45	142.87	19.05
EA	2.000	2.125	.875	50.80	53.97	22.22
EB	2.000	2.625	.875	50.80	66.67	22.22
EC	2.000	3.125	.875	50.80	79.37	22.22
ED	2.000	3.625	.875	50.80	92.07	22.22
EE	2.000	4.125	.875	50.80	104.77	22.22
EF	2.000	4.625	.875	50.80	117.47	22.22
EG	2.000	5.125	.875	50.80	130.17	22.22
EH	2.000	5.625	.875	50.80	142.87	22.22
FB	2.500	2.625	1.125	63.50	66.67	28.57
FC	2.500	3.125	1.125	63.50	79.37	28.57
FD	2.500	3.625	1.125	63.50	92.07	28.57
FE	2.500	4.125	1.125	63.50	104.77	28.57
FF	2.500	4.625	1.125	63.50	117.47	28.57
FG	2.500	5.125	1.125	63.50	130.17	28.57
FH	2.500	5.625	1.125	63.50	142.87	28.57
GC	3.000	3.125	1.250	76.20	79.37	31.75
GD	3.000	3.625	1.250	76.20	92.07	31.75
GE	3.000	4.125	1.250	76.20	104.77	31.75
GF	3.000	4.625	1.250	76.20	117.47	31.75
GG	3.000	5.125	1.250	76.20	130.17	31.75
GH	3.000	5.625	1.250	76.20	142.87	31.75
GJ	3.000	5.875	1.250	76.20	149.22	31.75
GN	3.000	8.625	1.250	76.20	219.07	31.75

*Series 3191 available in 1⅜", 1¾", 2" diameters only (case codes through EH).

PC MOUNT OVERALL HEIGHT (INCHES)

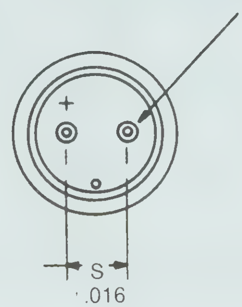
Case Length	H		
	D = 1.375	D = 1.750	D = 2.000
2.125	2.26	2.31	2.31
2.625	2.76	2.81	2.81
3.125	3.26	3.31	3.31
3.625	3.76	3.81	3.81
4.125	4.26	4.31	4.31
4.625	4.76	4.81	4.81
5.125	5.26	5.31	5.31
5.625	5.76	5.81	5.81

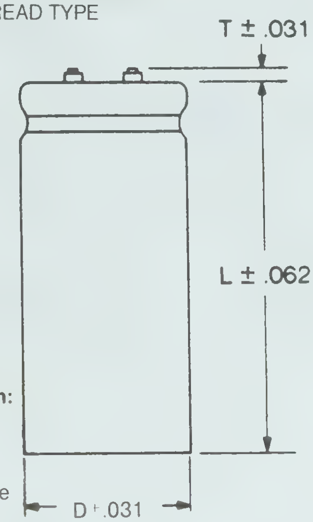
PC MOUNT TERMINAL SPACING (INCHES)

Case Diameter	X	Y	Z
1.375	.550	.500	.375
1.750	.900	.700	.525
2.000	1.000	.800	.575

CASE OUTLINE DRAWING

THREAD TYPE



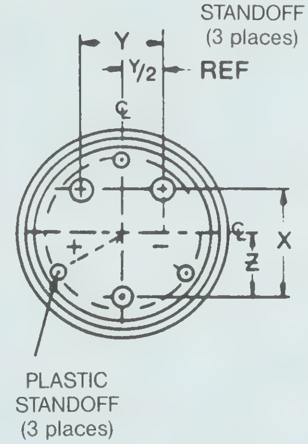


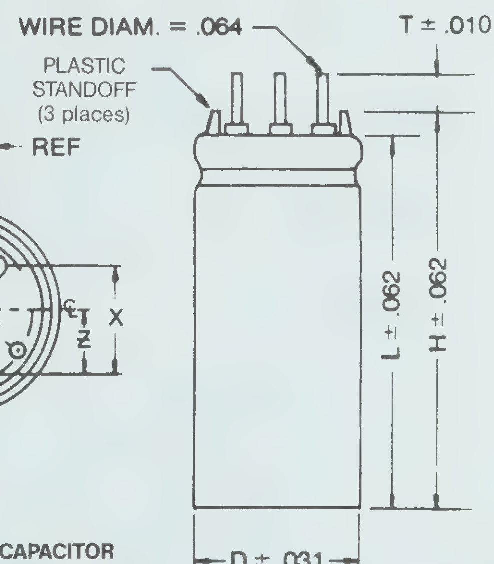
The capacitors are marked with:

- nominal capacitance
- rated voltage
- EIA source and date code
- maximum ambient temperature
- polarity
- name of manufacturer
- part number
- capacitance tolerance

CASE OUTLINE DRAWING

PRINTED CIRCUIT BOARD MOUNT





TOP VIEW OF CAPACITOR
(CIRCUIT SIDE OF PC BOARD)

TERMINAL STYLES, DIMENSIONS, AND CODE				
Terminal Style	T (inches)	T (mm)	Code	Thread Type
High Post	.250	6.4	A	10-32
Low Post	.063	1.6	B	10-32
High Current *	.125	3.2	D	¼-28
Solder Lug	.468	11.9	C	N/A
PC Mount**	.338	8.6	H	N/A

*Available in 2½" and 3" diameter cans only. Recommended for applications where ripple current exceeds 25 Amperes.

**T Dimension .250 inches & 6.4mm for 1⅜ and 2" dia for PC Mount. EA can only multiply .8 times capacitance table.

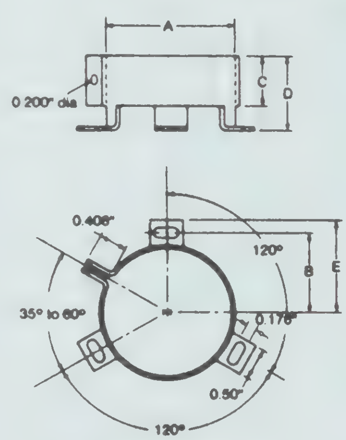
Aluminum Electrolytic Capacitors

Physical Specifications Snap-In Style

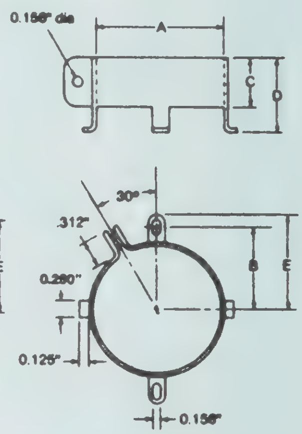
INSULATED CASE DIMENSION ADDER AND BRACKET CODES								
	INCHES			MM			BRACKET CODE	
INSULATION TYPE	D	L	H	D	L	H	without	with
.004 inch Polymeric	.010	.015	.010	.25	.38	.25	M	L
.008 inch Polymeric	.020	.032	.024	.508	.813	.61	P	R
.012 inch Polymeric	.025	.062	.045	.63	1.58	1.14	H	J
Uninsulated	–	–	–	–	–	–	N	X
MYLAR	.010	.015	.010	.25	.38	.25	D	E
LEXAN	.062	.375	–	1.57	9.52	–	S	T

BRACKET DIMENSIONS					
	Dimensions in Inches				
Case Diameters	A ±0.005	B ±0.031	C ±0.016	D ±0.031	E ±0.031
1.375	1.375	0.906	0.562	0.750	1.156
1.750	1.750	1.125	0.750	1.125	1.313
2.000	2.000	1.250	0.750	1.125	1.438
2.500	2.500	1.500	0.750	1.125	1.688
3.000	3.000	1.750	0.750	1.125	1.938
	Dimensions in Millimeters				
Case Diameters	A ±0.13	B ±0.79	C ±0.40	D ±0.79	E ±0.79
34.92	34.92	23.01	14.25	19.05	29.36
44.45	44.45	28.57	19.05	28.57	33.35
50.80	50.80	31.75	19.05	28.57	36.51
63.50	63.50	38.10	19.05	28.57	42.87
76.20	76.20	44.45	19.05	28.57	49.22

BRACKET OUTLINE DRAWING



For 1-3/4(D), 2(E), 2-1/2(F), and 3(G) inch diameter can sizes



For 1-3/8(B) inch diameter can sizes

Philips Components Series Capacitors can be completely specified using the following designation:

XXXX – **Philips Components Product Series**

BA – **Case Size Code**

942 – **Capacitance**
XX = Significant Digits
X = Multiplier
i.e. 942 = 9400μF

U – **Tolerance**
U = −10%+75%
T = −10%+50%

005 – **Voltage**
005 = 5VDC
050 = 50VDC

A – **Terminal Style**
A=High Post
B=Low Post
C=Solder Lug
D=High Current
H=PC Mount

M – **Insulation & Bracket Code** (see physical spec)

A-1 – **Factory Assigned Number**

HOW TO SPECIFY

Philips Components Series Capacitors can be completely specified using the following designation:

XXXX — **Philips Components Product Series**

DE — **Case Size Code** (See physical spec.)

102 — **Capacitance**
xx = Significant Digits
x = Multiplier
i.e. 102 = 1,000 uf

M — **Tolerance**
M = ±20%

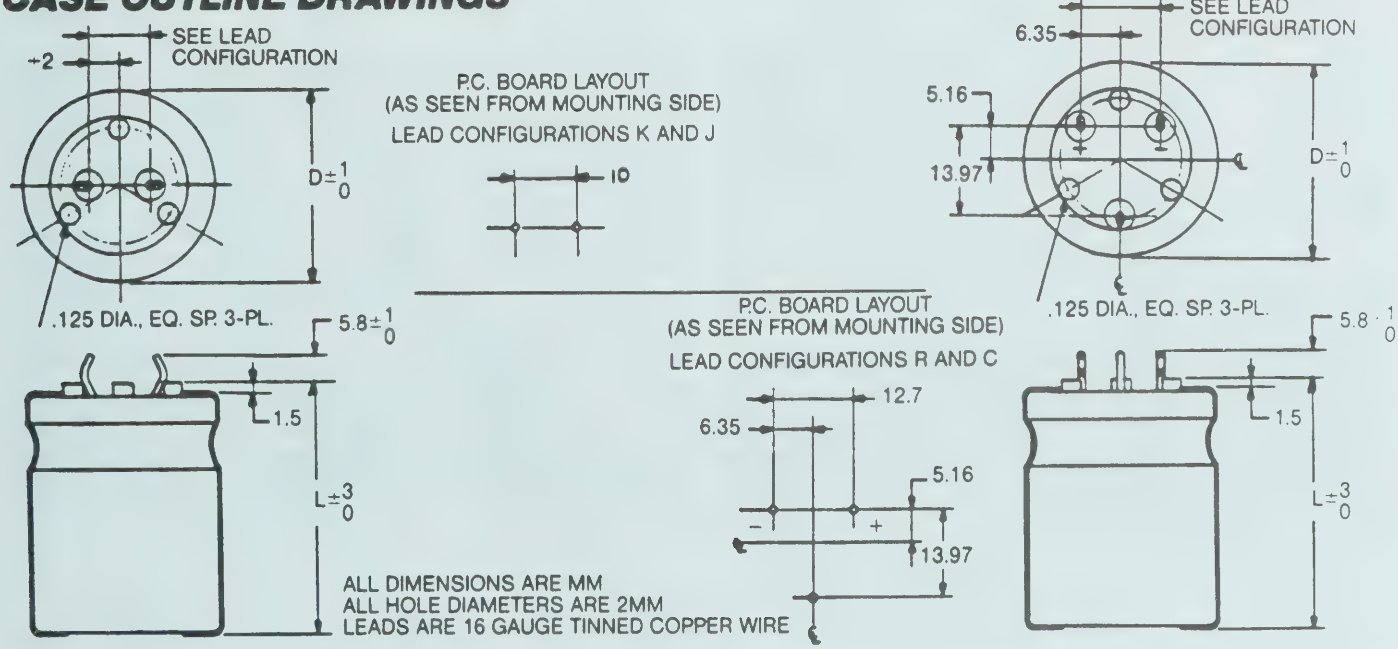
200 — **Working Voltage**

D — **Cover Construction**
D = Two leads 10.0mm spacing.
F = Three leads 12.7mm spacing.
(See physical spec.)

F — **Standard Insulation**
F = .006″ PVC

Case Codes	INSULATED CASE DIMENSIONS			
	Dimensions (mm)		Dimensions (in.)	
	$D\pm^{1}_{0}$mm	$L\pm^{3}_{0}$mm	$D\pm^{.039}_{0}$	$L\pm^{.118}_{0}$
BD	25	35	.984	1.378
BE	25	40	.984	1.575
BF	25	50	.984	1.969
CC	30	30	1.181	1.181
CD	30	35	1.181	1.378
CE	30	40	1.181	1.575
CF	30	50	1.181	1.969
CG	30	63	1.181	2.480
CH	30	80	1.181	3.150
DC	35	30	1.378	1.181
DD	35	35	1.378	1.378
DE	35	40	1.378	1.575
DF	35	50	1.378	1.969
DG	35	63	1.378	2.480
DH	35	80	1.378	3.150

CASE OUTLINE DRAWINGS



Aluminum Electrolytic Capacitors
MODERN ELECTROLYTIC CAPACITOR TECHNOLOGY

GENERAL

The ability of a capacitor to store electrical energy is a direct function of its mechanical geometry and its chemical composition. The amount of energy that it can store is given by the equation:

$$Q = CV$$

where Q = the magnitude of the stored charge
C = the capacitance in farads
V = the applied voltage

But the capacitance is determined by:

$$C + K\frac{a}{d}$$

where **a** is the directly opposing area of the plates, **d** is the distance between them (assumed to be uniform across the area), and **K** is the "dielectric constant" of the material separating them.

Engineers and scientists have been wrestling with these factors for generations, in the perennial effort to cram more and more capacitance into less and less space, in conformance with the unending trend of equipment miniaturization.

Obviously, increasing the area (**a**) of the capacitor plates will increase the capacitance of the device. This would tend to increase the size, but since only the area, not the thickness, of the plates is significant (in most applications) the plates could be made thinner to counteract the increase. Ways were developed to produce ever thinner metal foils, and eventually to deposit thin metallic films directly on both sides of a paper or plastic ribbon which can then be rolled up.

Reducing the thickness of the dielectric separator will also increase the capacitance of the device by reducing the distance (**d**) between the plates; this also reduces the size for a given capacitance, or allows more capacitance to be installed in a given space. Advancements in the production of high-quality, homogeneous plastic films of very thin gauges have enabled substantial reduction in capacitor size, combined with worthwhile increase in capacitance per unit volume.

Use of dielectric materials having higher dielectric constants will also increase the capacitance of the device, hopefully with a decrease (or at least no increase) in unit size. The search for better materials will continue.

One of the major breakthroughs in this field occurred about 85 years ago: the development of the electrolytic capacitor, a brilliantly ingenious expedient for obtaining high capacitance in a small space. Essentially, it consisted of an aluminum-foil ribbon, on the surface of which a thin film of aluminum oxide has been formed electrochemically, and a water-based electrolyte fluid which acts as the opposing plate. The oxide-coated foil, a second strip of aluminum foil, and a porous strip of paper interposed between them were rolled up together, and suspended in the liquid electrolyte, which penetrated the porous spacer. The physical relationship is diagrammed in Figure 1.

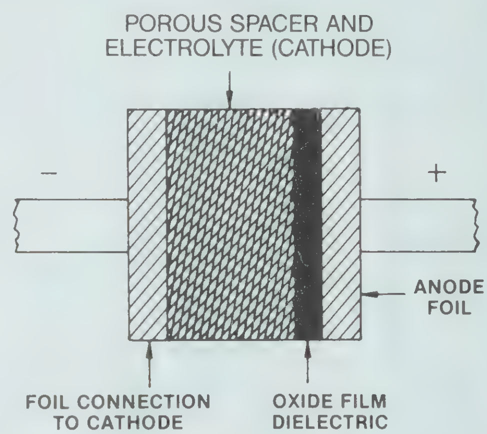


Figure 1. Polarized Electrolytic Capacitor.

The oxide-coated foil is the positive plate (anode), the aluminum oxide film is the dielectric, and the fluid electrolyte is the negative plate (cathode). The second strip of aluminum foil serves only as a connection in broad and intimate contact with the negative-plate electrolyte, and is usually bonded to the aluminum can that houses the capacitor. The porous strip prevents direct short-circuits between the two foil strips.

The oxide dielectric has a thickness on the order of 0.01 micron; thus the distance (**d**) between the "plates" has been reduced almost to the vanishing point. Furthermore, the dielectric constant (**K**) of this oxide is approximately 11. compared to 5

for paper, or 3 for polycarbonate or Mylar® plastic film. As a result, the capacitance per cubic inch in an electrolytic capacitor is increased tremendously, compared to conventional capacitor designs, even in the original electrolytic versions.

Over the years since their inception, there have been continuous improvements in electrolytic capacitor designs, and advancements in their technology. One of the most significant was that of etching the anode plate. The etching action exposes the grain structure, enormously increasing the area of the surface for a given area of foil. Etching of a given area of aluminum foil results in a many fold increase in the actual surface area facing the electrolyte plate, in the finished capacitor. Two other notable advancements were the development of non-aqueous and solid electrolytes, and of practical manufacturing techniques for the production of high-purity aluminum foil. Both of these factors will be examined in detail later, in conjunction with capacitor fabrication.

While the energy storage capabilities of aluminum electrolytic capacitors are impressive, electrolytic construction has certain inherent limitations that affect the use and performance of these capacitors. Safe operating voltages are limited to about 450 volts. The oxide dielectric has rectifier properties, blocking current flow in one direction but offering low resistance in the opposite direction; it is therefore limited to DC applications, and a voltage reversal of more than a volt or two will cause breakdown of the film and destruction of the capacitor. (Non-polarized types for AC applications are available. Their construction is essentially the same as shown in Figure 1, but *both* foils are coated with oxide dielectric, constituting two capacitors connected back to back). The power factor of electrolytics is considerably higher than those of other capacitor types, and the broad plate area makes for appreciable leakage.

PRODUCTION TECHNOLOGY

The design and fabrication of an electrolytic capacitor is an extremely complex science. The physical principles involved, and their interlocking—and occasionally mutually exclusive—relationships have been the subject of continuous, heavy research for more than 80 years. Some of the developments that have evolved are discussed below.

The Anode (Positive Plate). Capacitance is directly proportional to the surface area of the capacitor plates. This factor has been uniquely exploited in electrolytic design by etching the surface of the anode foil, either *chemically,* by immersion in an acid bath such as hydrochloric acid, or *electrochemically* by immersion in a conductive, corrosive bath such as a solution of sodium chloride, and applying an electric current to the foil and solution. In both cases, the etching action exposes the grain structure of the metal, enormously increasing the area of the surface for a given area of foil. The degree of etch is controlled by immersion time in chemical etching, and by the regulation of current flow in electrochemical etching.

The presence of impurities (principally copper, silicon, magnesium, iron, and zinc), in the anode foil, can result in early failure of an electrolytic capacitor. Particles of other metals do not form an oxide barrier layer as aluminum does, hence constitute leakage paths. They also form galvanic couples with aluminum and will produce hydrogen gas in the presence of an electrolyte, besides reducing the efficiency of the oxide-layer barrier and causing generation of excessive heat. For these reasons, high-purity aluminum is used for foils, and the electrochemical etching process is the most suitable for use on this material. Lower-purity aluminum is used for the cathode foil.

In the electrochemical etching process, high etching-current density produces a fine etch pattern, with very high surface gain. However, when this surface is anodized (as discussed later) to voltages above 100 volts, the thickness of the oxide layer formed will bridge over some of the fine depressions of the etch pattern, reducing the surface gain, and the forming reaction will cause mechanical erosion of the peaks of the etch, further reducing the effective area.

Using the lower etching-current density produces a coarser surface, but the higher resistance to erosion and over-bridging results in a higher final capacity, when anodized at higher voltages. Thus, there is a trade-off relationship between etch coarseness and forming voltage in achieving maximum capacity at a selected working voltage, in a capacitor of given size. It is possible to custom-tailor the etch for optimum capacity at

a given voltage.

The foil is run as a continuous ribbon through the precleaning bath, then over a roller which supplies the current for etching, then down into the etching tank, then through a series of baths that remove the etch solution, neutralize residual salt, remove loose metal particles, and wash away any remaining materials carried over from the processing tanks. The foil is then dried and immediately rolled, and protected from the atmosphere to prevent formation of "non-barrier" oxide prior to its entry into the anodizing, or forming, process.

Two types of "anodized" films can be formed on aluminum. In contact with moist air, the surface layer of aluminum forms a porous oxide of regular structure and low resistance, known as non-barrier oxide. When immersed in certain electrolyte solutions and connected to a DC power source as an anode with the solution as a cathode, the surface layer of aluminum forms an impervious, amorphous film of aluminum oxide having the property of restricting the flow of current in one direction and permitting it to flow in the opposite direction. This barrier oxide layer has a thickness which is a function of the applied voltage—approximately 14 angstroms per volt, at room temperature. The forming voltage must be considerably higher than the proposed operating voltage, to provide adequate dielectric strength over a long operating life despite aging effects. Leakage current increases rapidly as the operating voltage approaches the forming voltage value, particularly in "wet" electrolytics.

Needless to say, the foil, the electrolyte, and the tanks and apparatus must all be of the highest purity, and cleanliness. The presence of impurities can result in porosity in the oxide film, and can cause some dissolving of the film in the electrolyte—an effect that can double for every 10°C rise in the temperature of the solution. Impurities remaining in the elements of a finished capacitor will cause reactions that will result in high leakage, early deterioration, and outright failure after a short operating life.

The Electrolyte. In an electrolytic capacitor the electrolyte constitutes the second electrode, or plate, separated from the anode, or positive plate by the barrier layer of oxide formed on the anode surface. Ideally, it must be chemically inert, and have good temperature stability, and the proper conductivity. If the conductivity is too low, a high ESR (equivalent series resistance) results, with consequent high loss factor. If the conductivity is too high for the rated operating voltage, electrolytic breakdown in the form of sparking occurs (known as "scintillation"), resulting in failure of the capacitor.

"Wet" electrolytic capacitors use a liquid electrolyte; the solvent (usually from the glycol family), some form of conductive salts, and a controlled amount of water. A porous ribbon of a nonconductive material such as a highly absorbent paper is wound as a separator between the two foils, and this ribbon is saturated with the electrolyte. The construction of such a capacitor is shown on Figure 2. The rolled element is installed in a cylindrical metal container which may be connected to the cathode foil. A plastic sleeve is provided on some types, to facilitate the use of off ground applications.

Limiting the amount of water in the electrolyte limits gassing and chemical activity, thereby increasing life expectancy. Low water levels in electrolytes also increase the shelf life. Using solvents less viscous than glycols, as an example amides, and more soluble salts, enables the electrolyte to penetrate into the fine etch structure of the foil more readily, thus contacting a greater surface area. This increases the ratio of unit capacitance to contact area and further reduces E.S.R.

Low viscosity electrolytes have additional desirable characteristics, they maintain more uniform conductivity at higher frequencies as shown in Figure 3, enhancing their utility as components in switching regulated power supplies. The lower E.S.R. also enables these units to handle higher ripple currents than previously permitted.

The resistivity of electrolytes particularly with high water content, varies with temperature especially below 25°C. This results in high loss of capacitance and increase in E.S.R. at temperatures below −10°C. The high water content in electrolytes also limits their use to a maximum temperature of +85°C. At these high temperatures they have limited life expectancy and shelf life. Local sites in the aluminum foil are activated by water, allowing exposure of bare metal. This results in high leakage current when a stored capacitor is subjected to applied voltage. If this leakage

current can reach a sufficient magnitude from an unregulated source, the unit may go into thermal runaway, with subsequent failure.

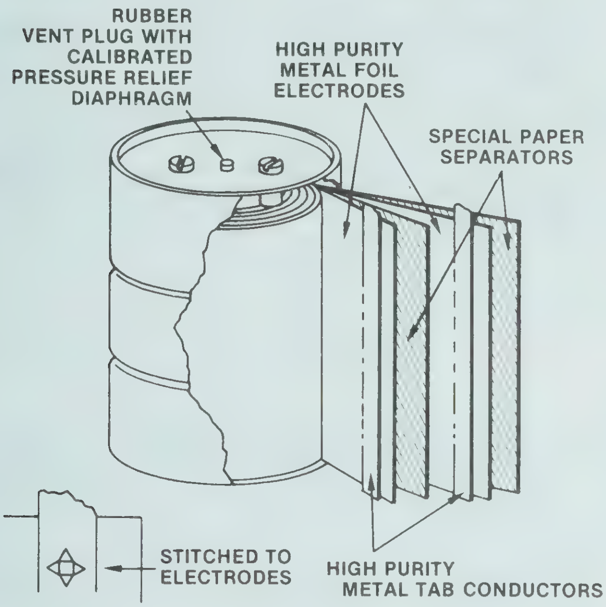


Figure 2. Basic construction of a concentrically wound computer grade electrolytic capacitor.

At extremely low temperatures, conventional glycol family electrolytics lose in excess of 35% of their capacitance, and increase their E.S.R. manyfold, in relation to their room temperature values. These effects are caused by the increase in resistivity of the electrolyte, due to increased viscosity or sometimes by crystalization, as well as its shrinkage from the etch pattern of the foil. This results in poor contact between the electrolyte and the foils. This type of capacitor becomes a practically pure resistive device at −60°C due to these effects.

While it is a fact that amide based electrolytes produce capacitors with superior low temperature characteristics, such as an 80% capacitance retention at −55°C, they have several undesirable characteristics. The vapor pressures of amide base electrolytes are much higher than for glycols, thereby requiring superior sealing characteristics, and special materials in their containers. The high vapor pressures effect the long term life at high temperature operation. The toxicity of the amides is also considerably greater than glycols and they may also have adverse ecological effects.

Philips Components has developed non-aqueous, glycol family, electrolytes that possess excellent E.S.R. characteristics and superior, long term, high temperature operation. This is illustrated in Figure 4. This shows the superior E.S.R. stability of the glycol electrolyte vs the amide based on at 105°C operation.

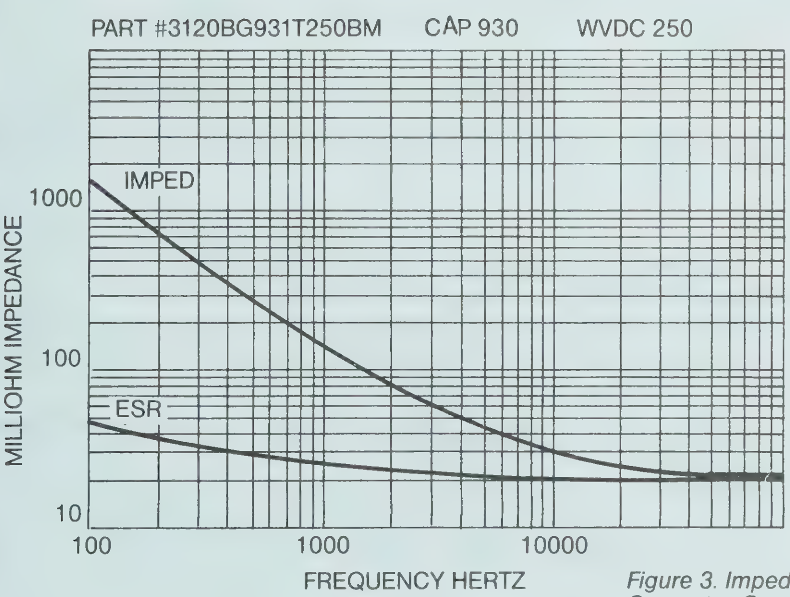


Figure 3. Impedance vs. Frequency Characteristic of Standard Computer-Grade Electrolytic Capacitors.

MODERN ELECTROLYTIC CAPACITOR TECHNOLOGY

LIFE TEST CHARACTERISTICS
ESR @ 105°C DMF VS GLYCOL
LOW VOLT ELECTROLYTE

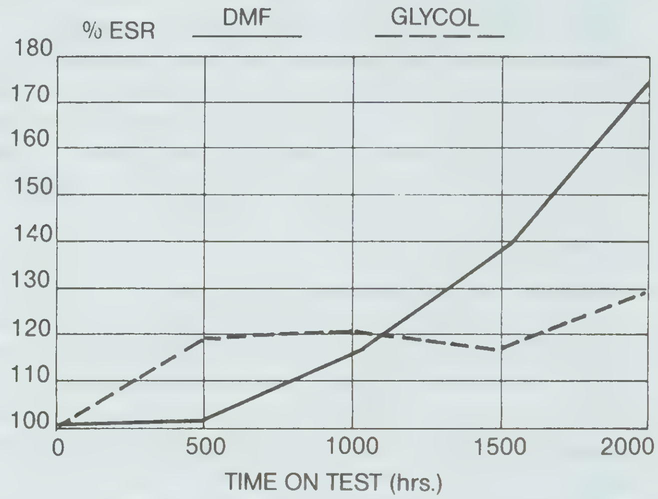
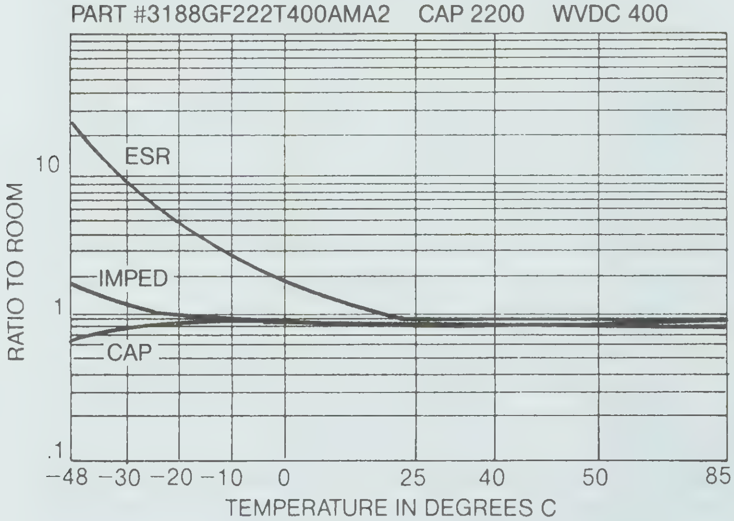


Figure 4. E.S.R. Stability comparison at high temperature of amide vs. glycol base electrolytes.

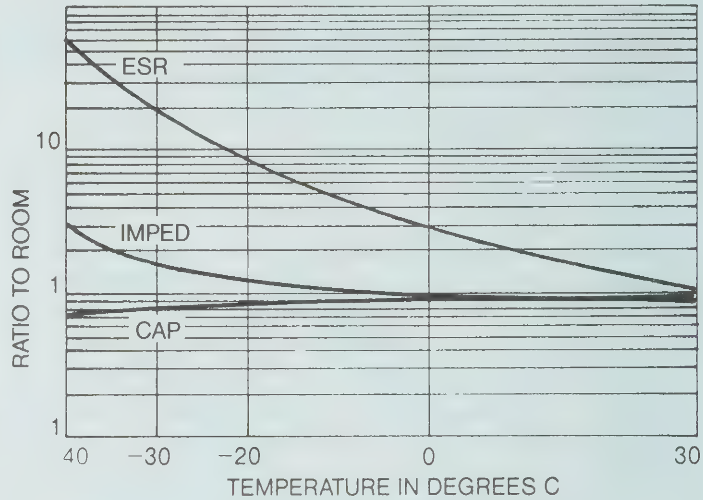
While the low temperature characteristics are somewhat inferior, the following curves should indicate that they are quite acceptable for all but the most critical military applications.

The following figures illustrate typical low temperature operating characteristics with the newly developed and utilized electrolytes.

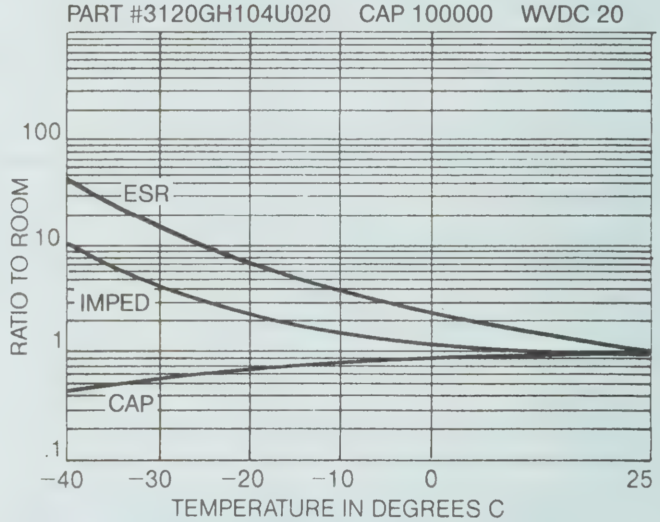
PART #3188GF222T400AMA2 CAP 2200 WVDC 400



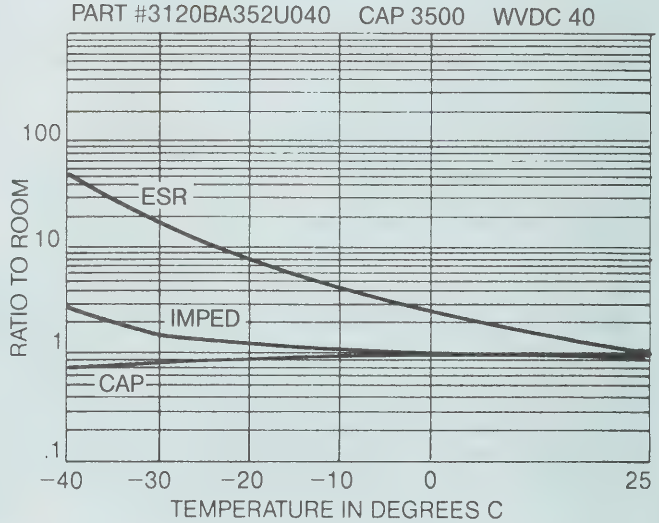
PART #3120EC122T250 CAP 1200 WVDC 250



PART #3120GH104U020 CAP 100000 WVDC 20



PART #3120BA352U040 CAP 3500 WVDC 40



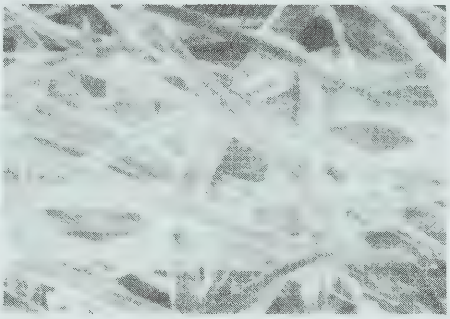
The Spacer. The characteristics of the spacer that separates the foil ribbons influence the ESR of the capacitor. Each type of spacer has a resistance factor dependent upon its density, type of fiber, and fiber shape. In the design of low-ESR capacitors, it is essential to use spacers with low resistance factors. At present, the lowest resistance-factor spacers are of the lowest-density types, and since this low density is associated with minimum mechanical strength, special equipment is required to utilize them effectively. Proper design sometimes involves use of more than one spacer for optimum electrical characteristics and ease of manufacture. Figure 9 presents microphotographs of various spacers, showing their fiber structure.

The Cathode. The cathode foil in an electrolytic capacitor serves as a means of making extended contact with the electrolyte throughout the length and breadth of the separator strip. However, it also effectively forms another capacitor with the electrolyte, in series with the anode capacitor. The total effective capacitance is:

$$\frac{1}{C_{total}} = \frac{1}{C_{anode}} + \frac{1}{C_{cathode}}$$

Theoretically, the cathode foil has no insulation or oxide coating; its capacitance therefore should be infinitely large, and the total capacitance would be governed by the anode alone. Actually, a thin oxide film of some sort forms on the metal through exposure to the atmosphere and to the electrolyte, reducing this capacitance, though in all but low-voltage electrolytics it is considerably higher than the anode capacitance because of the relative thinness of the cathode film.

Non-polar electrolytic capacitors are essentially two capacitors connected back to back. Both foils are anodized to form oxide barrier layers, and they share the electrolyte in common. The system is inefficient, having a high power factor due to the large ESR, but is an effective and economical device in such AC applications as motor-starting capacitors where the intermittent use allows time for dissipation of generated heat between operations. The capacitor manufacturer is well equipped to advise a customer on his specification, and his application, to maximize performance and life at minimum cost, and to adjust his processes to produce the idealized capacitor.



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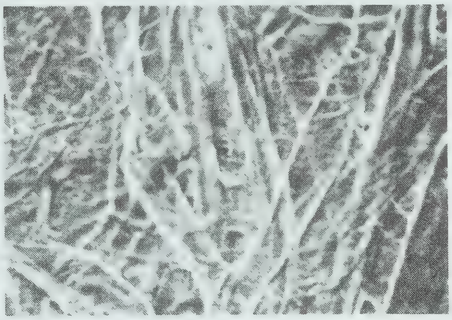
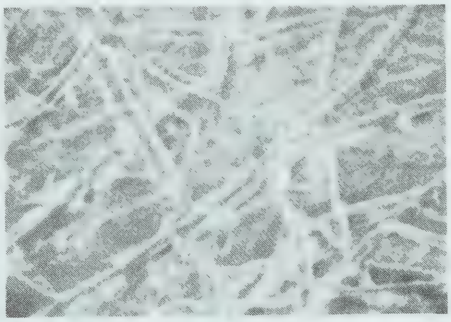
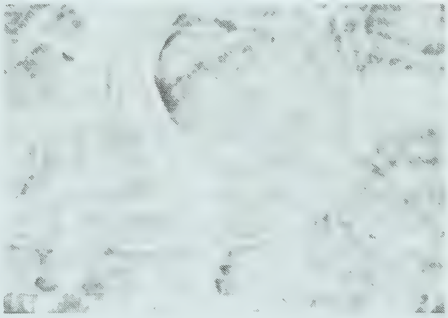


1A-69 PAPER 0.001 SE 400X 75426



1A-69 PAPER 0.001 BEN 400X 7432



1A-69 PAPER 0.001 KAK 400X 75428

Figure 9. Fiber Structures of Spacers.

ELECTRO-MECHANICAL CONSIDERATIONS

Several mechanical innovations have been incorporated into electrolytic capacitor design, aimed at improving the electrical performance as well as the efficiency of these components. A very significant one is the multi-tabbing of the foil windings. Since the foil cross-section is extremely small, the foil resistance can be appreciable, especially in the larger-diameter units. An effective method for minimizing this resistance is to install several connection tabs at equal distances along the length of the foils. This has the effect of connecting the resistance of the segments in parallel, thereby reducing the total resistance of the foil ribbon, and lowering the ESR.

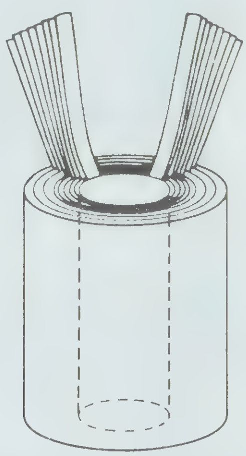


Figure 10. Multi-Tabbed Doughnut-Wound Capacitor.

The coiled helices of foil, being effectively in series with the conductive paths in the capacitor, also contribute some inductance to the ESL (equivalent series inductance) of the unit. But multi-tabbing reduces this effect significantly, not only by connecting the inductances of the segments in parallel, but also by the bifilar action of the centered tabs. For most effectively minimizing ESR and ESL, the tabs must be placed in the exact mathematical center of each segment; this placement is now accomplished by computerized techniques, which locate the tabs for optimum electrical performance, and for mechanical ease of assembly. Figure 10 shows this multi-tabbed construction; and Figure 11 shows typical characteristics achieved with this design. Capacitors of this construction can attain ESR values of less than 2 milliohms in the 120Hz-40kHz frequency range.

Another benefit of the multi-tabbing technique is greater realization of capacitance in high-capacitance, low-voltage units. Since the unit capacitance with its associated individual foil resistance is a strip-line network, reduction of this resistance increases the effective capacitance at the terminals of the device.

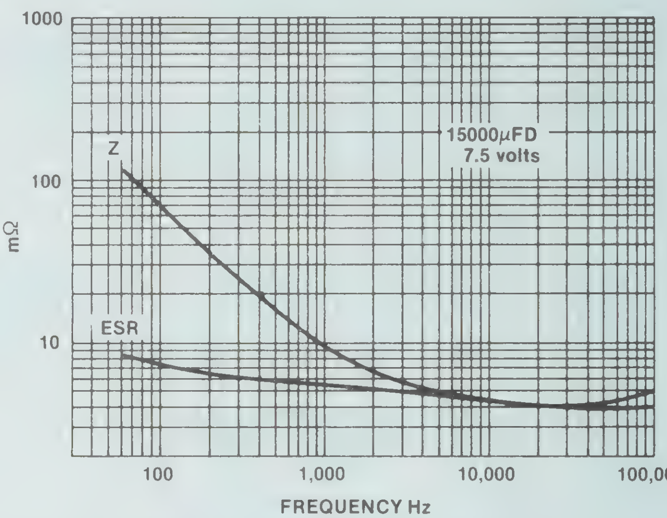


Figure 11. Impedance and ESR vs. Frequency, Philips Components High-Frequency Capacitor.

Another recent improvement is the elimination of potting compound. This is available on special order when a higher than standard vibration is a requirement. In previous designs, a bituminous compound was used to anchor the capacitor element in its metal case to prevent damage or failure due to mechanical vibration; this compound, being a poor thermal conductor, constituted a barrier to efficient heat dissipation from the element. Philips Components developed a method (patent pending) of crimping the sides of the case to achieve direct contact with the capacitor element as shown in Figure 12. This achieves a positive anchoring of the element, preventing its movement in any direction when subjected to vibration.

Direct and firm contact between case and element provides excellent thermal conductivity from the element to the ambient atmosphere and chassis or frame support, resulting in cooler operation of the capacitor. In addition, absence of potting material results in uniform gas expansion space in each unit, increasing the operating life of the capacitor. Units with this construction

are the most suitable for mounting in any plane during operation.

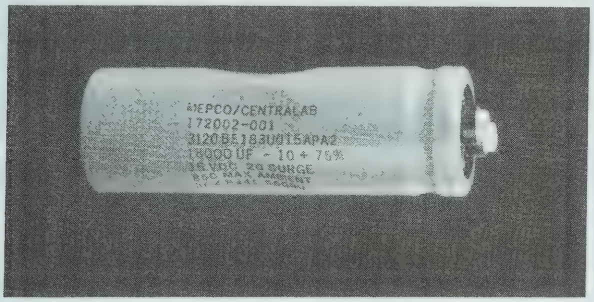


Figure 12. Crimped Case.

Further enhancement of the thermal efficiency of the unit is achieved by winding the capacitor element with a large core opening (see Figure 10). The development of foils with higher capacitance per unit area decreases the foil length required for a given capacitance rating. By keeping the outer diameter constant, for efficient roll contact with the case, and increasing the internal core size, a higher thermal efficiency is realized.

DEFINITION OF CAPACITOR PARAMETERS

Electrically, an ideal capacitor exhibits only capacitance between its terminals—no resistance, no inductance—and when a varying voltage is applied, the current flowing in it will lead the voltage applied across it by 90°. In practical capacitors the situation is as shown in Figure 15, the lumped-parameter circuit for a capacitor. Because of its physical construction and composition, the capacitor unavoidably includes both inductance and resistance in series with the capacitance, and minute leakage paths through the dielectric add some resistance in parallel with the capacitance.

ESL, the "equivalent series inductance," is determined by the mechanical construction of the finished capacitor. ESR, the "equivalent series resistance," in an electrolytic capacitor is determined by the electrolyte, the spacer, the dielectric (barrier oxide), and the foil resistance. R_L, the DC resistance due to leakage current, is determined by the qualities of the dielectric. The actual values of these lumped parameters vary quite widely among electrolytic capacitors because of differences in size, and in forming techniques, as well as in construction and composition. In any given capacitor, they also vary with ambient conditions, and with applied voltage, waveform, and frequency. What is more, they often vary in a non-linear manner. For these reasons, capacitor parameters must often be qualified by stating range limitations and conditions of operation. This has some significant influences on the equipment designer's choice of a capacitor, and its performance in a particular application, as indicated in the following discussions.

CAPACITANCE. The capacitance of an electrolytic capacitor is normally stated in microfarads, though the time is approaching when single units will offer one or more farads of capacitance in a container of practical size. The forming process used to establish operating voltage ratings is a precise science, but it is not yet exact. Therefore

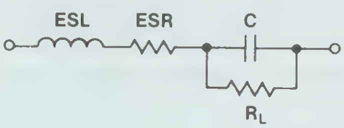


Figure 15. Equivalent Circuit of a Practical Capacitor.

the actual capacitances achieved in capacitors of a particular production run will vary somewhat from unit to unit, and these units are cataloged within a liberal capacitance tolerance. Most applications for electrolytic capacitors are uncritical of exact capacitance values, and require only that the capacitance exceed a nominal minimum value.

CAPACITANCE TOLERANCE (ACCURACY). This tolerance is stated as the maximum positive and negative deviations of the capacitance from a rated nominal value, at a standard test temperature (usually 25° ±3°C), measured at a standard frequency (usually 120 Hz), at a negligibly low test voltage (usually 1 volt). It is usually expressed as a percentage of nominal capacitance. Common tolerances are −10% +50%, −10% +75%, and ±20%. Closer tolerances are available on special order, for critical applications.

> **Notes:** Measurements at other than the standard test temperature *must* allow for the temperature characteristic (see blow) of the capacitor. "Negligibly low test voltage" means that the test voltage applied is not high enough to cause significant temperature rise due to losses and/or leakage. Usually at the standard test frequency, the test voltage is not critical.

TEMPERATURE CHARACTERISTIC (OF CAPACITANCE). The variation of capacitance with temperature, in electrolytic capacitors, is non-linear, particularly in the region below room temperature. To list an over-all average numerical temperature coefficient would be misleading, since the coefficient is quite small at conventional operating temperatures, and substantially larger at low temperatures. Electrolytics are not ordinarily utilized in thermal-compensation or stabilization schemes, but their performance over a specific temperature range is usually of interest to the circuit designer, and their temperature characteristics are customarily provided in graphic form (see Figures 5 and 8 for typical examples of glycol vs. amide electrolytics).

The temperature characteristic of capacitance for a given type or model electrolytic capacitor will vary with the nominal capacitance and voltage ratings.

> **Note:** The temperature reference in this characteristic is that of the capacitor, not the ambient temperature.

DC WORKING VOLTAGE. This is the maximum voltage at which a capacitor may be operated continuously, over its rated operating temperature range. Voltages in electronic and electrical circuits are often DC with an additional AC component consisting of ripple or noise signals, fluctuations due to power-line variations, etc. The specified DC working voltage rating includes the *total* (DC plus peak AC) voltage that may be applied in continuous operation. The AC component must not be allowed to exceed the DC component, to avoid polarity reversal and possible destruction of the capacitor.

SURGE VOLTAGE. Electrolytic capacitors can usually withstand an occasional brief pulse or surge of voltage beyond their rated DC working voltage without being damaged. A surge rating is established for each type or model, which includes ripple, noise, power-line fluctuations and *all* transient occurrences. This rating is on a non-recurrent basis, and should never be exceeded, even momentarily.

EQUIVALENT SERIES RESISTANCE (ESR). The ESR of a capacitor is a standard characteristic, expressed in ohms, representing all energy losses in the "equivalent" series resistance of a capacitor, regardless of source: lead resistance, termination losses, dissipation in the dielectric material, foil resistance. It assumes that all losses can be represented by a single resistance in series with the idealized perfect capacitor. The power losses caused by it result in internal heating of the device, which in turn affects the useful expected life, the impedance (a major factor in applications), and the permissible ripple current.

ESR is strongly dependent upon the operating temperature of the capacitor, and varies inversely with it as can be seen in Figures 7 and 8. This variance is primarily the result of the contribution of the electrolyte—spacer combination to the total ESR of the capacitor.

An added source of ESR is found in the resistance of the aluminum foil itself, due to both the series resistance of the foil and the resistance of the oxide on the anode foil. The higher voltage ratings will have higher ESR values due to thicker anodic oxide films.

Since in large capacitors the length of the foil ribbon is considerable, and the actual cross-section of the foil is relatively thin due to the

etching of the surfaces, significant resistance exists. This resistance is further affected by the individual etch patterns used, but may be controlled to some extent by adjusting the foil area-to-capacitance ratios; that is, the higher the ratio of foil area to unit capacitance, the lower the ESR produced.

EFFECTIVE SERIES INDUCTANCE. The effective series inductance of a capacitor, which is a function of its mechanical construction, dominates the impedance of the device above the self resonant frequency. This can become a limiting factor in higher frequency applications such as switch mode power supplies. The self resonance of the capacitor is that frequency at which the inductive reactance and the capacitive reactance are equal in magnitude and opposite in phase. At this frequency the impedance of the device is equal to the ESR.

RIPPLE CURRENT. When a periodic (AC) voltage wave is superimposed on the DC voltage applied to an electrolytic capacitor–i.e., when the filter capacitor in a DC power supply is being charged by the rectifier and discharged by the external load–current flows into and out of the capacitor. This "ripple current" flows through the ESR of the capacitor, generating heat which increases the internal temperature of the unit.

Being an electrochemical device, the capacitor is subject to deterioration, including a shortened life, by temperature increases. The higher temperatures cause an increase in leakage current, and loss of electrolyte through the seals; the current flow initiates electrolysis of the electrolyte, generating gas, and decreasnig the quantity of electrolyte, which in turn causes a decrease in capacitance and an increase in ESR. The failure mode typically is a loss of capacitance to the point that the power supply ripple voltage will be beyond the specified limit.

Manufacturers of electrolytic capacitors usually offer several grades of capacitors, rated by their length of accelerated life under test. Generally, the essential differences between these grades are the level of leakage current allowed, the type of electrolyte used, and the quality of the sealing method used. Figures 16 and 17 illustrate the difference in operating life between two Philips Components types: the Series 3186 and Series 3120.

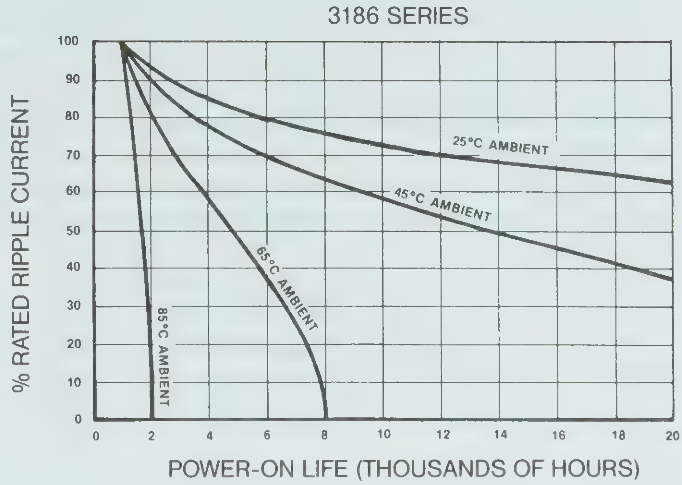


Figure 16. Series 3186–Life vs. % Rated Ripple Current and Ambient Temperature (at 100% Rated Voltage)

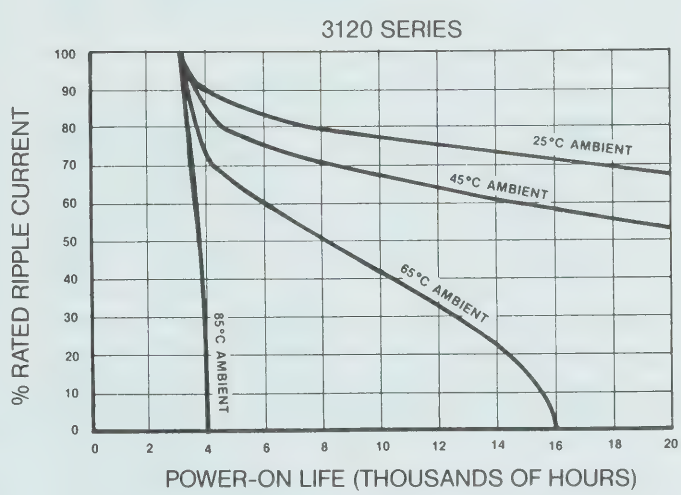


Figure 17. Series 3120–Life vs. % Rated Ripple Current and Ambient Temperature (at 100% Rated Voltage)

At a 45°C ambient temperature, and 50% of the rated ripple current at that temperature, the 3186 has an expected life of 14,000 power-on hours with 100% rated voltage applied. Under the same rated conditions, the 3120 will have a power-on life of 22,000 hours. The lifetime of both Series will be extended further if the applied voltage is reduced from the 100% value.

Aluminum Electrolytic Capacitors
MODERN ELECTROLYTIC CAPACITOR TECHNOLOGY

Ripple current through the capacitor can be measured in several ways, some more accurate than others. Figure 18 illustrates three of these methods. The first method shown is the most accurate. The current is read directly from a True RMS current probe. The second method, reading the RMS voltage across a very-low-resistance shunt and using Ohm's Law to derive the current works very well, if the resistance of the shunt is less than 10% of the impedance of the capacitor. The third method is perhaps the easiest, but is the least accurate if the actual impedance of the capacitor is not known. The ripple current can be approximated by dividing the RMS voltage by the calculated impedance:

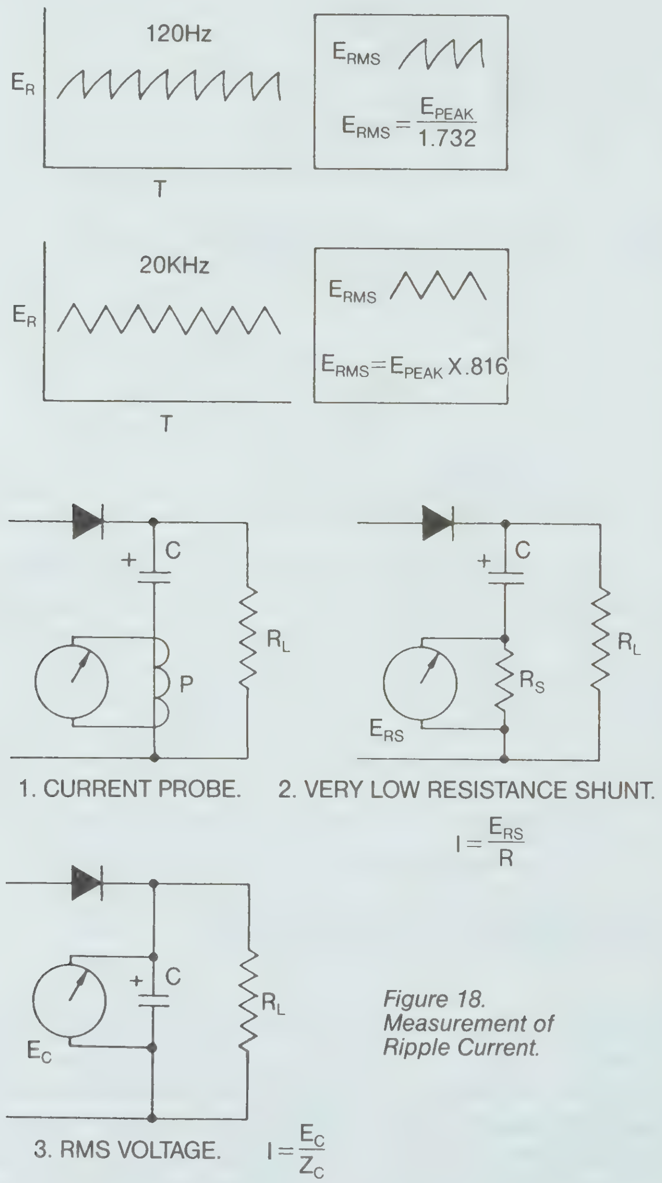


Figure 18. Measurement of Ripple Current.

$$Z_c = \sqrt{ESR^2 + (X_L - X_C)^2}$$

$$X_c = \frac{1}{2\pi fC}$$

$$X_L = 2\pi fL$$

f = frequency, C = Farads, L = Henries

where the ESR, capacitance, and inductance are the values specified in the manufacturer's literature.

QUALITY, DISSIPATION, AND POWER FACTORS. These three factors are discussed together because they are interrelated, and are sometimes misinterpreted when described individually. Quality Factor (or Q) is simply the ratio of the capacitor's reactance to its resistance (X_C/R) at a specified frequency. It should be as high as possible, since a lower ratio indicates higher power loss. Dissipation Factor (DF) is the reciprocal of Quality Factor: $DF = 1/Q = R/X_C$. It should be as low as possible, since high DF represents a high power loss. Power Factor (PF) is the ratio of resistance to impedance (R/Z) and represents the fraction of input voltamperes (or power) dissipated in the capacitor. Quality Factor and Dissipation Factor are terms associated with DC capacitors. Power Factor is primarily associated with AC motor start capacitors.

INSULATION RESISTANCE AND DC LEAKAGE CURRENT. I_R is a measure of the capacitor's ability to retain a charge with respect to time. It is the ratio of the DC test voltage impressed across to the current that flows through it (at a specified voltage and temperature). This current is measured 5 minutes after the capacitor has been charged to the test voltage. The capacitor then appears as a high resistance in parallel with an ideal (non-leaky) capacitor. Insulation resistance is sometimes expressed in megohms for small capacitors and as a time constant (the product of R and C in megohm-microfarads) for higher-value capacitors. It should not be confused with the equivalent series resistance.

About This Section...

In these notes, we discuss and analyze the major design problems most frequently encountered in capacitor applications. The presentation assumes that the reader has: (1) read the immediately preceding sections entitled Modern Electrolytic Capacitor Technology and Technical Notes (pages); (2) acquired adequate experience in conventional circuit design; and (3) gained reasonable facility with the mathematics of linear-circuit computations. Where appropriate, an accesible bibliographic reference is given.

We have attempted to make this presentation mathematically rigorous and physically realistic. When a simplifying assumption *has* been made, it has been noted...and, if necessary, explained.

One final word: these are the design-engineering topics that we feel you are most likely to encounter; but there are many others that arise less frequently, yet are challenging, and can be critical to circuit performance and reliability. You are invited to consult us about any such engineering problem in the application or selection of aluminum electorlytic capacitors. Write or call:

Applications Engineering Department
Philips Components
6071 St. Andrews Rd.
Columbia, South Carolina 29212-3198

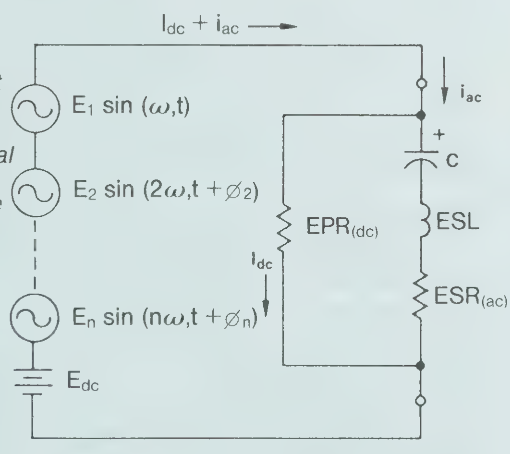


Figure 1. Equivalent circuit of an electrolytic capacitor and for non-sinusoidal (but periodic) AC ripple voltage with significant DC component.

Ripple Voltage and Current; Total Dissipation.

Figure 1 shows the "general cases" for both the applied voltage and the parameters of the equivalent circuit of the capacitor. Note the following:

1. The applied voltage comprises the series combination of a dc voltage and a *periodic* ac waveform of unvarying shape and amplitude. By Fourier analysis,* it can be shown that any continuous, periodic waveform can be expressed as the sum of a set of sinewave signals of various relative amplitudes and phases. The lowest-frequency signal has a frequency $f_1 = 1/\tau$, where τ is the period of the original waveform. The other sinewave signals in the set occur at integral multiples of that lowest frequency (i.e., at $2/\tau$, $3/\tau$, $4/\tau \ldots n/\tau$), and are called the "second, third, fourth,... and nth *harmonic* components of the original waveform.

2. The amplitudes and phases of all harmonic components present can be computed from the Fourier integral and the geometry of the original ac ripple-voltage waveform. Although some waveforms have an *infinite number of harmonic components,* the amplitudes of the higher-order harmonics are negligibly small. In waveforms exhibiting "mirror symmetry" (between the geometries above and below E_{dc}), only the odd harmonics exist–i.e., the fundamental and the third, fifth, seventh, etc. The phase relationships are often restricted to 0° and 180° (plus or minus sinewave polarities). Figure 2 shows a number common periodic ac ripple waveforms and their Fourier expansions.

3. In precise ripple-current computations, the rms values of the individual harmonic current components may be individually determined, then summed by a formula that involves taking the square root of the sum of the squares of all significant harmonic current amplitudes, as shown in example #2, below.

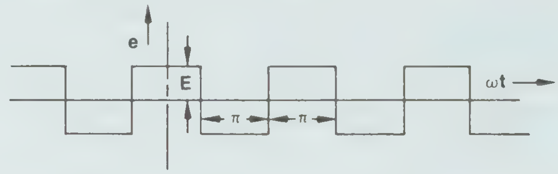
4. There is one simpler case than that just described. It is illustrated in example #1, in which the ripple voltage is assumed to be a pure sine wave, at 120Hz; hence, there are no harmonic components. The ac impedance of the capacitor at 120Hz is known, from catalog data supplied, and need not be computed. *In this one special case,* the rms ripple current is computed simply by dividing the rms value of the applied ripple voltage by the (120-Hz) impedance of the capacitor. The dissipation due to ripple current is, then, $(I\ ac\ rms)^2$ X ESR. To this must be added the dissipation

*See any text dealing with spectral analysis. Publications like the ITT handbook (any edition) are also useful aids.

Aluminum Electrolytic Capacitors
DESIGN ENGINEERING NOTES

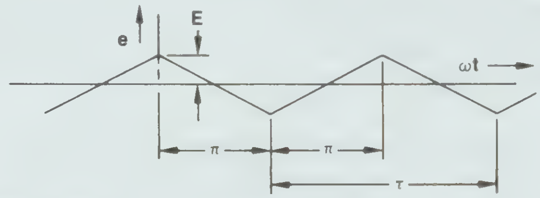
FOR ALL WAVEFORMS:

τ = period $= \frac{1}{f}$ $\quad 2\pi f = \omega \quad 2\pi ft = \omega t$



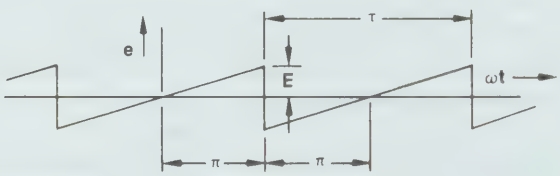
Square wave

$$e(t) = \frac{4}{\pi} E \left(\cos(\omega t - \frac{1}{3}\cos(3\omega t) + \frac{1}{5}\cos(5\omega t) - \frac{1}{7}\cos(7\omega t) + \ldots\right)$$



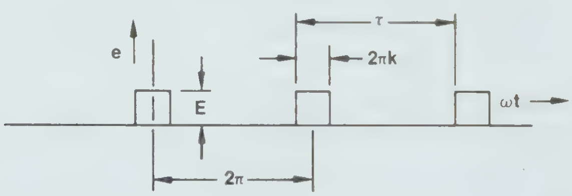
Triangular wave

$$e(t) = \frac{8}{\pi^2} E \left(\cos(\omega t + \frac{1}{9}\cos(3\omega t) + \frac{1}{25}\cos(5\omega t) + \ldots\right)$$



Sawtooth wave

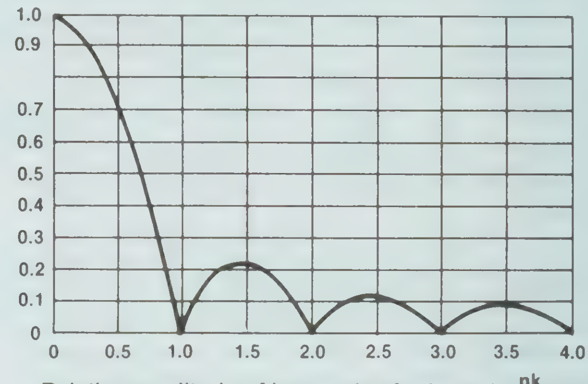
$$e(t) = \frac{2}{\pi} E \left(\sin(\omega t - \frac{1}{2}\sin(2\omega t) + \frac{1}{3}\sin(3\omega t) - \frac{1}{4}\sin(4\omega t) + \ldots\right)$$



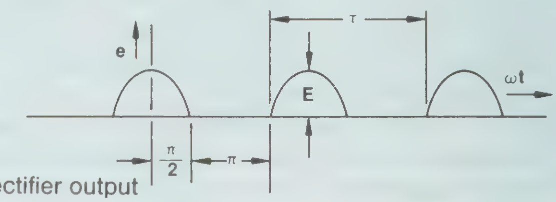
Short square pulse

$$e(t) = E\left[k + \frac{2}{\pi}\left(\sin k\pi \cos(\omega t + \frac{1}{2}\sin 2k\pi \cos(2\omega t) + \frac{1}{3}\sin 3k\pi \cos(3\omega t) \ldots + \frac{1}{n}\sin nk\pi \cos(n\omega t) \ldots\right)\right]$$

The relative values of the coefficients of cos nx are plotted below as a function of nk for the case k <<1, i.e., for short pulse. Under these conditions the coefficients of cos nx are proportional to sin nkπ)/nkπ.

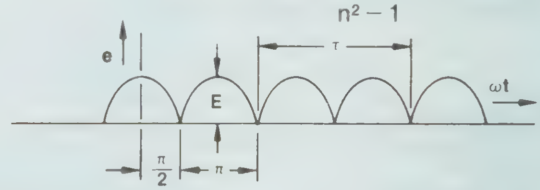


Relative amplitude of harmonics for k <<1.



Half-wave rectifier output

$$e(t) = \frac{1}{\pi}E\left(1 + \frac{\pi}{2}\cos(\omega t) + \frac{2}{3}\cos(\omega t) - \frac{2}{15}\cos(4\omega t) + \frac{2}{35}\cos(6\omega \ldots (-1)^{\frac{n}{2}+1}\frac{2}{n^2-1}\cos(n\,\omega t)\ldots\right)$$



Full-wave rectifier output

$$e(\omega t) = \frac{2}{\pi}E\left(1 + \frac{2}{3}\cos(2\omega t) - \frac{2}{15}\cos(4\omega t) + \frac{2}{35}\cos(6\omega t) \ldots (-1)^{\frac{n}{2}+1}\frac{2}{n^2-1}\cos(n\,\omega t)\ldots\right)$$

Figure 2.
Harmonic Composition of Some Common Periodic Waves.

due to leakage, which is Edc X Idc, where Idc is the rated maximum leakage current at the operating temperature.

5. In the generalized equivalent circuit of the capacitor shown in the right-hand side of figure 1, the leakage resistor is shown as EPR, the Equivalent Parallel Resistance. It is safely assumed to be constant and independent of both applied voltage and frequency, provided only that the applied Edc is at least 30% of the rated working voltage of the capacitor. It *is* temperature-dependent to some extent. The methods of measuring Idc and ESR are such as to separate them effectively. ERS is, however, sensitive to frequency, operating temperature, and (to a much lesser extent) to the applied dc and ac voltages.

Returning to Figure 1, it should be clear that the left-hand side of the diagram represents any applied ripple voltage, having any dc component, and any amplitude and wavefore of variation, provided only that the variations are truly periodic. Thus, figures 1 and 2 provide the basis for a generalized technique for computing ripple current from applied voltage (of any waveform or period) and from the parameters of the capacitor.

The capacitor parameters are shown on right-hand side of figure 1. Remember that the methods used for measuring ESR and EPR keep them separate and independent. Therefore, EPR is assumed to dissipate power *only* due to the dc leakage current (Idc); and ESR is assumed to dissipate power *only* due to the rms ac ripple currents (appropriately summed as Iac), caused by the individual Fourier ac voltage components.

Example No. 1. This example considers the simplest practical case of the application of the foregoing theory. In it, the applied voltage is the sum of a dc voltage and a single sine wave. Such a ripple waveform is applied across the capacitor when a full-wave rectifier drives the capacitor through a multi-section low-pass, "choke-input" LC filter having a fairly sharp cutoff just above the fundamental ripple frequency. (Even a single large inductance between the full-wave rectifier and the capacitor closely approaches the example.) Given the applied voltage values and the capacitor parameters listed below, what dissipation occurs in the capacitor?

Edc	$=200V$	$C=400\mu F$
Eac	$=6\sin(\omega t)$	X_L at $120Hz=0.008\Omega$
ω	$=2\pi(120)=$ 754	ESR at $120Hz=0.1\Omega$
		EPR at $250Vdc=10^6\Omega$

The dc leakage current is simply the ratio of Edc to EPR, or

$$Idc = 200/10^6 = 200\mu A = 0.2mA$$

and this dissipates a power equal to the product of EDC and Idc, or

$$Pdc = 200 \times 0.2 \times 10^{-3} = 40mW = 0.04W$$

The ac computation is slightly more difficult, but equally straightforward, since only a single frequency is involved.

$$Zac = ESR + j\omega ESL - j\frac{1}{\omega C} \text{ (a vector sum)}$$

In this example, both ESR and $j\omega ESL$ are negligibly small compared with $1/j\omega C$ *at 120 Hz,* so we may write:

$$Zac \cong 1/j\omega C$$

(Note that the normal data given for this capacitor includes its 120Hz impedence, which may be used in place of the $1/j\omega C$ computed for Zac) and we may ignore the j, since all it tells us is that the current Iac leads the applied ac voltage by 90°. Therefore,

$$Zac = 1/\omega C = 1/(400 \times 10^{-6} \times 754)$$

or $Zac = 3.32\Omega$

and we may compute Iac

$$Iac = 6\sin(754t)/3.32 = 1.81\sin(754t).$$

In other words, Iac is a sine wave of current having a peak value of 1.81 amperes. For a sine wave, the rms value is 0.707 times the peak value, so

$$Iac \cong 0.707 \times 1.81A = 1.28A \text{ rms}$$

and the power dissipated in ESR is

$$Pac = (Iac\ rms)^2\ ESR = 0.16W$$

and the total power dissipated in the capacitor is

$$Pt = Pac + Pdc = 0.16W + 0.04W = 0.2W$$

Aluminum Electrolytic Capacitors
DESIGN ENGINEERING NOTES

Example No. 2. In this second example, we consider a 400μF capacitor with the same ESR and ESL, to which we apply a *sawtooth* ripple-voltage waveform, superimposed on a large Edc, as before. As we shall see later, this type of ripple waveform can occur when the rectangular-wave output of a switching regulator at, say, 95% duty cycle is fed to the capacitor through an inductor. Referring to figure 2, we find that the Fourier components of a sawtooth wave occur at both even and odd harmonics, diminishing in amplitude inversely as the order of the harmonic. If we assume a 3.14V peak-to-peak ripple amplitude superimposed on the 200V Edc, and $1/\tau$ = 400Hz, what dissipation occurs in the capacitor?

Edc=200V
Eac=3.14V p-p sawtooth
τ =1/400 seconds
C =400μF
ESL=10.6μH
X_L=0.008Ω at 120Hz
ESR=0.1Ω, assumed constant over the spectrum from 400Hz to 2,400Hz*

The dc leakage current at 25°C and rated voltage is given by:

$$Idc = 200/10^6 = 0.2mA.$$

which causes a dissipation in EPR of:
Pdc = 200 x 0.2mA = 0.04W.

*See typical DF-vs-frequency curve, figure 3. DF = (ESR X ωC).

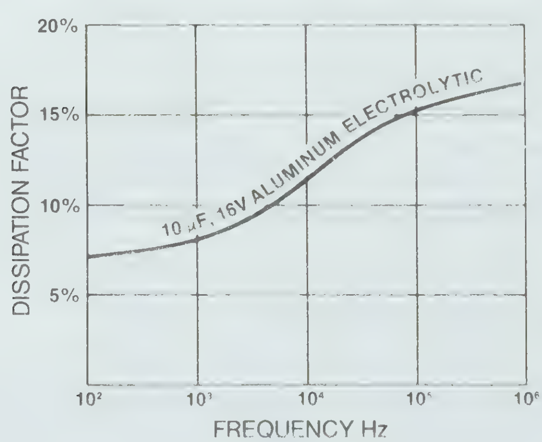


Figure 3. DF vs. Frequency for Electrolytic Capacitors.

The ac computation is best handled by a chart format, as shown below.

f	$\omega(2\pi f)$	E peak
400Hz	2,500	2V
800Hz	5,000	1V
1,200Hz	7,500	0.67V
1,600Hz	10,000	0.50V
2,000Hz	12,500	0.40V
2,400Hz	15,000	0.33V

$$e(t) = \frac{2}{\pi}(3.14)\ \sin(\omega t) - \frac{1}{2}\sin(2\omega t) + \frac{1}{3}(\sin 3\omega t) - \frac{1}{4}\sin(4\omega t) + \ldots$$

(The first six harmonics of sawtooth wave, from figure 2)

ω	$1/\omega C$	ωL	ESR	$1/\omega C - \omega L$
2,500	1.0 Ω	0.0264Ω	0.1Ω	0.974Ω
5,000	0.5 Ω	0.0528Ω	0.1Ω	0.447Ω
7,500	0.33Ω	0.0792Ω	0.1Ω	0.251Ω
10,000	0.25Ω	0.1056Ω	0.1Ω	0.144Ω
12,500	0.20Ω	0.132Ω	0.1Ω	0.068Ω
15,000	0.10Ω	0.264Ω	0.1Ω	0.164Ω

ω	Zac	Epeak	Ipeak	Irms
2,500	1.04Ω	2.0V	1.9A	1.4A
5,000	0.55Ω	1.0V	1.8A	1.3A
7,500	0.27Ω	0.67V	2.5A	1.8A
10,000	0.17Ω	0.5V	2.9A	2.1A
12,500	0.12Ω	0.4V	3.3A	2.3A
15,000	0.19Ω	0.33V	1.7A	1.2A

ω	Irms	I^2rms	Pac (=ESR X I^2rms)
2,500	1.4A	$2.0A^2$	0.2W
5,000	1.3A	$1.7A^2$	0.17W
7,500	1.8A	$3.3A^2$	0.33W
10,000	2.1A	$4.4A^2$	0.44W
12,500	2.3A	$5.3A^2$	0.53W
15,000	1.2A	$1.4A^2$	0.14W

Pac = 1.81W (Fundamental through 6th harmonic)

The total power dissipated is given by:

$$Pt = Pdc + Pac = 0.04 + 1.81 = 1.85W$$

A number of useful facts may be deduced by analyzing and comparing the results of examples 1 and 2.

- At low-frequencies—i.e., well below resonance—only the capacitance and ESR are significant. Even the ripple-voltage *waveform* is not very important, if most or all of the high-amplitude harmonics fall below resonance. In both examples we have used a capacitor that is resonant at about 2.5kHz:

$$f\,res = \frac{1}{2\pi\sqrt{LC}}$$

that is, the frequency at which

$$2\pi fL = \frac{1}{2\pi FC}$$

"L" in the above formula is the ESL of the capacitor. For $L = 10.6\mu H$ and $C = 400\mu F$, f res = 2,445Hz.

- So great is the diffeence between signals falling well below resonance and those approaching resonance, that the 6V p-p ripple voltage of example 1 causes only about *one-tenth* the dissipation of the *smaller* signal (3.14V p-p) used in example 2... because the smaller signal has harmonic components near the capacitor's resonant frequency; in fact, the fifth harmonic falls just below resonance, and the sixth is just above it.
- In both examples, note that we have used as a starting point the ripple *voltage* across the capacitor, *not* the ripple current flowing through it. If we *had* known the rms ripple current, then it would only have been necessary to square that current, and multiply the result by ESR:

$$Pac = (Irms)^2\ ESR\ watts.$$

- If a number of rms ripple current (e.g., at different frequencies, as in example 2) are to pass through the same ESR, the dissipation may be computed by the principle of superposition, using the sum-of-squares formula:

$$Pac = [(I_1)^2 + (I_2)^2 + (I_3)^2 + \ldots (In)^2]\ ESR\ watts$$

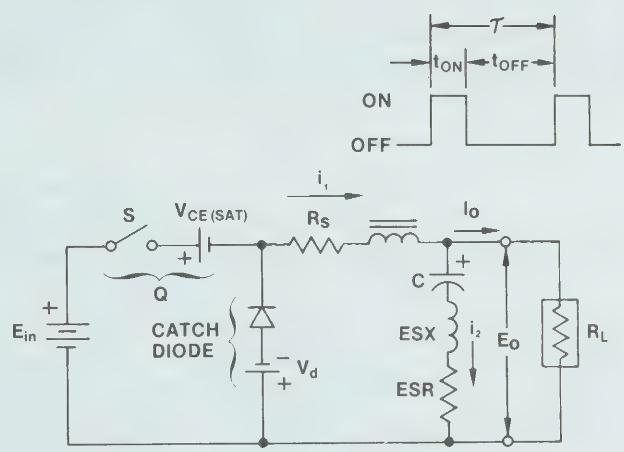
where I_1, I_2, I_3, etc. are each rms values.

Capacitor Calculations for Switching Regulator Output Circuits

For the specialist designer in motor controls and power supplies, this introductory treatment will, no doubt, convey very little new information. The technical literature of the past few years has piled up a mass of detailed analytical approaches, some of them involving complex mathematics.

For the engineer who wishes to make a good *start* on the design of the basic regulator (figure 4), and of many popular variations of this basic type, the following is well worth reading.

Figure 4. Equivalent circuit representative of many "constant-frequency," or duty-cycle-modulated switching regulators.



The circuit operates at a fixed frequency; that is, τ in figure 4 is a constant—say 100μsec for a 10 kHz regulator. The control of E_O is achieved by changing the duty cycle (α) of the control of the switching transistor.

$$\alpha = \left[1 - \frac{\tau on}{\tau}\right]$$

Aluminum Electrolytic Capacitors
DESIGN ENGINEERING NOTES

Figure 5 relates the various parameters around the circuit to critical currents and voltages that are established by the designer. Figure 5 presents a total of six sets of parametric curves, all synchronously related on a time "ladder," and the reader will find it possible, by moving from 5a to 5f, in various random sequences, to perform the three design tasks he must complete before the details of the electronics circuit can be attacked.

For example, figure 5f allows one to start with the required output voltage and the sum of the load and capacitor current (figure 5b) to read the product 2$\triangle$VRC. From this computation, one can use figure 5d to determine the value of C.

One final note about figures 4 and 5. The results obtained from manipulations of figure 5 will not give completely valid results if the X_L shown in figure 4 is significant in magnitude to ESR. Furthermore, the results obtained in such a situation are "optimistic." Tending to yield smaller values of C and lower power dissipation. Using the new aluminum electrolytics with amide electrolytes, it is possible to obtain extremely large values of capacitance in which the X_L term is negligible compared to ESR.

It is obvious that we are not able to present the complete subject in this condensed summary. Two or three sample designs, however, treated as exercises, should serve to give the reader sufficient versatility with this rigorous and comprehensive view.

Figure 5. Relationships among parameters of Figure 4, assuming $X_L <<< ESR$.

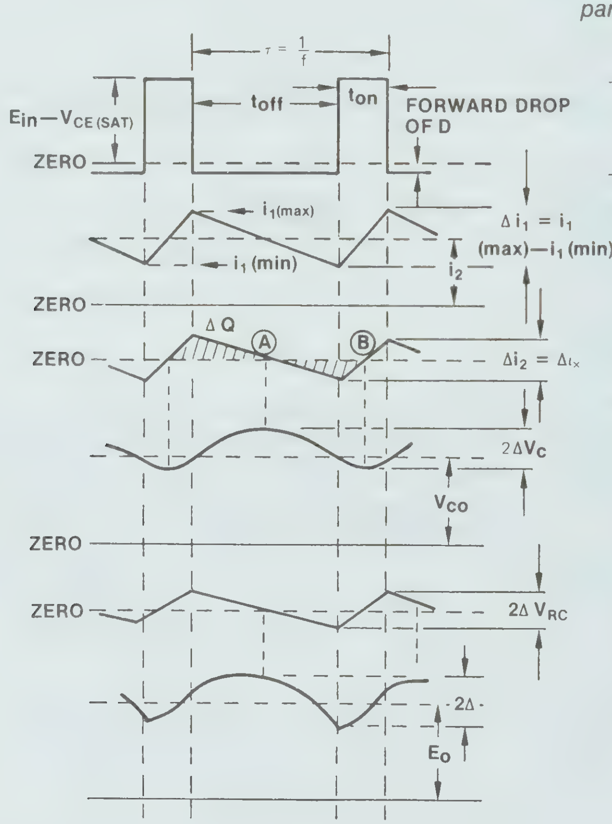


Figure 5a. Voltage across D.

Figure 5b. Current through L.(i_2).

Figure 5c. Current through C. (i_2).

Figure 5d. Voltage across capacitor c. (V_c).

Figure 5e. Voltage across R_C. (V_{RC}).

Figure 5f. Output voltage.

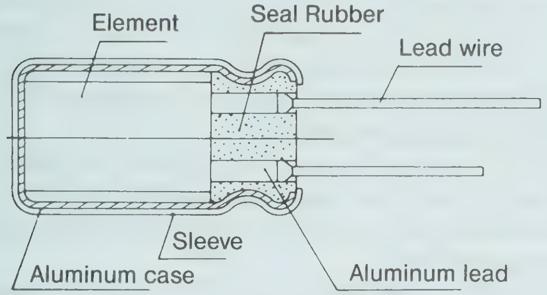
Application Guidelines

Plug-in Axial and Radial Lead Types

Proper handling of aluminum electrolytic capacitors in equipment assembly can insure good performance of the capacitors and a long life.

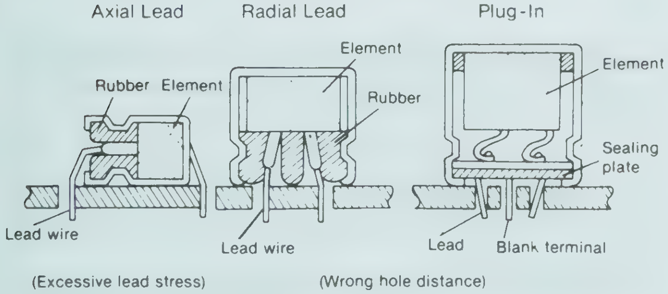
Insulation

General purpose types of aluminium electrolytic capacitors are covered with a sleeve made of vinyl chloride or the like. This sleeve is used for marking. When the internal element or the container needs to be electrically isolated, capacitors specially designed for insulation requirements should be used.



Mounting

The distance between the terminal holes on the circuit board should be the same as that between the lead wires or terminal of the capacitor. Excessive force in mounting on circuit boards should be avoided.



1. Axial and Radial Lead Types

Improper insertion of the lead wires in circuit boards may cause electrolyte leakage or break the lead wires or impair their connection with the internal elements. When the distance between the two terminal holes on the circuit board can-' not be reduced to that between the lead wires, lead-formed capacitors are recommended.

Lead stress should not exceed 1.5 kg.

2. Plug-in Type

Improper insertion of the terminals in circuit boards may break the terminals or impair their connection with the internal elements.

The blank terminal of a multi-terminal capacitor should be considered to be at the same potential as the electrolyte and should therefore be isolated from the circuit. When the blank terminal cannot be electrically isolated from the circuit, a capacitor with a blank terminal that is insulated from the capacitor element should be specified.

Soldering

Incorrect soldering may shrink or break the sleeve. Please read the following information carefully, before soldering.

1. Too high a soldering temperature or too long a soldering time may cause secondary shrinking of the sleeve which unnecessarily exposes the container. No problems will be observed at a soldering temperature of 260°C or below for no more than 10 seconds.

2. Soldering may melt or break the sleeve, if the sleeve is in contact with circuit patterns. To avoid this problem, the capacitors should be mounted slightly raised from the circuit board. (Lead-formed capacitors are recommended.)

3. Sleeve may be melted by solder which has migrated up through the terminal holes on the circuit board. To avoid this problem, the same application as stated in the foregoing paragraph is recommended.

4. When soldering, heated lead wires or terminals of adjacent components may tear the sleeve if contacted. Please mount carefully so as not to bring adjacent components' terminals or lead wires into contact with the sleeve, particularly when mounting on through-hole circuit boards.

Application Guidelines

Plug-in Axial and Radial Lead Types

Cleaning

Aluminum can be aggressively attacked by halide ions, particularly by chloride ions. Even small amounts of chloride ions inside of the capacitor will cause corrosion accidents—rapid capacitance drop and venting. Therefore, the prevention of chloride contamination is the most important check point for quality control in our production lines.

At present, chlorinated hydrocarbon organic solvents such as Trichlene,™ Chlorocene,™ and Freon™ are commonly used to remove soldering pastes from circuit boards. However, if general purpose types of aluminum electrolytic capacitors, whose seal constructions are not solvent-proof, are cleaned with such solvents, the solvents may gradually penetrate the seal portion and corrode the inside of the capacitor.

Accordingly, only alcohol base solvents are recommended for cleaning. Chlorinated hydrocarbons are not recommended.

The mechanism of corrosion of aluminum electrolytic capacitors by chloride ions can be explained as follows:

Chlorinated solvents are absorbed and diffuse through the polymer seal to enter the inside of the capacitor. Various chemical reactions may occur depending upon the particular solvent and electrolyte, but the final result is release of chloride ion.

Chloride ion can penetrate through imperfections and micro-cracks in the aluminum oxide dielectric layer to reach the underlying aluminum metal. At these points the metal is attacked with production of a soluble chloride in this anodic half-cell reaction:

$$Al+3Cl^{-} \rightarrow AlCl_3+3e \quad \text{(8)}$$

There is always at least 1-2% water in the electrolyte and this is sufficient to hydrolyze the $AlCl_3$:

$$AlCl_3+3H_2O \rightarrow Al(OH)_3+3H^{+}+3Cl^{-} \quad \text{(9)}$$

This reaction releases chloride ion for further attack of aluminum. The hydrogen ion increases the local acidity which causes oxide dielectric to dissolve.

Thus localized corrosion occurs at an accelerated pace with attack of both metal and dielectric.

Recommended cleaning solvents therefore are those free of halogen. When halogenated solvents must be used, solvent-proof capacitors, whose seal construction are specially designed, are recommended.

Some adhesives, dampproofing agents and dustproofing agents also contain halides and should be used with caution.

Cleaning of "Solvent Resistant" Capacitors

The load life test specifications shall be satisfied after the capacitors are subjected to the following cleaning conditions.

Freon TE® or **Freon TES**®

Max. cleaning time: 5 minutes
Cleaning method: Immersion, ultrasonic, or vapor

—Caution—

1. The capacitors can withstand the immersion cleaning with chlorothene for a maximum of 5 minutes at the normal temperature. However, PVC sleeve swells with chlorothene and then may shrink by heat at drying process. Consult for chlorothene cleaning.
2. When the lead spacing of the capacitor is different from the hole spacing to the PC board, use the lead forming type capacitor to prevent stress on seal.
3. Consult for flux to be used and other cleaning conditions.

(Freon TE and Freon TES are registered trademarks of Dupont, Inc.)

Storage

The characteristics of electrolytic capacitors depend on temperature; the higher the ambient temperature, the faster the deterioration proceeds (leakage current increase, tan δ increase and capacitance drop). Humidity is another deteriorating factor. Capacitors may have their lead wires/terminals oxidize, impairing solderability, when stored in humid places for long periods of time.

Aluminum electrolytic capacitors should be stored at room temperature in dry places out of direct sunlight.

Capacitors stored at room temperature for not more than 2 to 3 years will show a negligible rise in the leakage current and will need no special treatment.

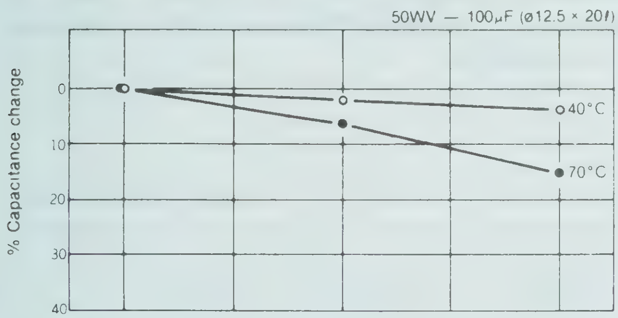
If aluminum electrolytic capacitors are stored above room temperature for long periods of time, the anode foil may react with the electrolyte to increase the leakage current. The application of even normal voltages gives such capacitors larger leakage currents, whereby the amount of gas

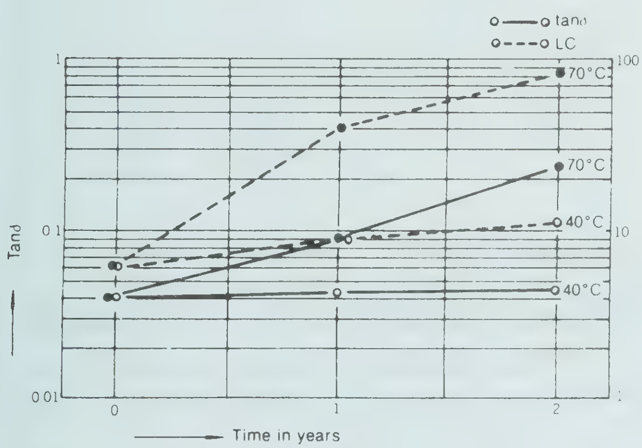
generated may cause the safety vent to open.

Capacitors stored for long periods of time should be subjected to a voltage treatment* which reforms the dielectric. By this reform process, leakage current is reduced to the initial level. Leakage current increase varies with working voltage of the capacitors, normally in the order:

Low voltage capacitors<Middle voltage capacitors<High voltage capacitors.

Effect of Storage Time and Temperature





***Note**
The voltage treatment is to gradually increase the applied voltage up to the rated value so that the current is set to the capacitor's specified leakage current value, and then keep the applied voltage at the rated value for 30 to 60 minutes.

General Guidelines For Using Electrolytic Capacitors

1. Electrolytic capacitors for DC application require polarization.

Confirm the polarity. If used in reversed polarity, the circuit life may be shortened or the capacitor may be damaged. For use in circuits whose polarity is occasionally reversed, or whose polarity is unknown, use bi-polar capacitors. Also, note that an electrolytic capacitor cannot be used for AC application.

2. Do not apply a voltage exceeding the capacitor's voltage rating.

If a voltage exceeding the capacitor's voltage rating is applied, the capacitor may be damaged as leakage current increases. When using the capacitor with AC voltage superimposed on DC voltage, care must be exercised that the peak value of AC voltage does not exceed the rated voltage.

3. Do not exceed ripple current specification.

Use the electrolytic capacitor at current values within the permissible ripple range. If the ripple current exceeds the specified value, request capacitors for high ripple current applications.

4. Determine the operating temperature range.

Use the electrolytic capacitors according to the specified operating temperature range. Usage at lower temperature will ensure longer life.

5. The standard electrolytic capacitor is not suitable for circuits in which charge and discharge are frequently repeated.

If used in circuits in which charge and discharge are frequently repeated, the capacitance value may drop, or the capacitor may be damaged. Please consult our engineering department for assistance in these applications.

6. Apply voltage treatment to the electrolytic capacitor which has been allowed to stand for a long time.

If the electrolytic capacitor is allowed to stand for a long time, its working voltage is liable to drop, resulting in increased leakage current. If the rated voltage is applied to such a product, a large leakage current occurs and this generates internal heat, which damages the capacitor. If the electrolytic capacitor is allowed to stand for more than 2-3 years, apply a voltage treatment.

7. Cleaning circuit boards after soldering.

Some solvents have adverse effects on capacitors. Ask our engineering department about suitable cleaning agents.

Application Guidelines

Plug-in Axial and Radial Lead Types

8. Do not place a soldering iron on the body of the capacitor.
The electrolytic capacitor is covered with a vinyl sleeve to insulate the case. If the soldering iron comes in contact with the electrolytic capacitor body during wiring, damage to the vinyl sleeve and/or case may result in defective insulation, or improper protection of the capacitor elements.

9. Be careful of temperature and time when soldering.
When soldering a printed circuit board with various components, care must be taken that the soldering temperature is not too high and that the dipping time is not too long. Otherwise, there will be adverse effects on the electrical characteristics and insulation sleeve of electrolytic capacitors. In the case of small-sized electrolytic capacitors, nothing abnormal will occur if dipping is performed at less than 260°C for less than 10 seconds.

10. Do not apply excessive force to the lead wires or terminals.
If excessive force is applied to the lead wires and terminals, they may be broken or their connections with the internal elements may be affected. (For strength of terminals, refer to JIS C5102, C5141 and C5142.)

11. Care should be used in selecting a storage area.
If electrolytic capacitors are exposed to high temperatures caused by such things as direct sunlight, the life of the capacitor may be adversely affected. Storage in a high humidity atmosphere may affect the solderability of lead wire and terminals.

12. Surge voltage.
The surge voltage rating is the maximum DC overvoltage to which the capacitor may be subjected for short periods not exceeding approximately 30 seconds at infrequent intervals of not more than five minutes. Unless otherwise specified, the rated surge voltages are as follows:

Rated Voltage (V)	6.3	10	16	25	35
Rated Surge Voltage (V)	8	13	20	32	44

Rated Voltage (V)	50	63	80	100	160	200
Rated Surge Voltage (V)	63	79	100	125	200	250

Rated Voltage (V)	250	315	350	400	450
Rated Surge Voltage (V)	300	365	400	450	500

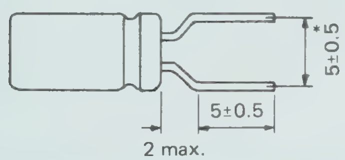
13. Capacitor case sizes and other product standards specified in this catalog may be changed or modified without notice for improvement of quality.

LEAD CUT AND LEAD FORMING

Case dia. of ϕ5 to ϕ8 Unit (mm)

FC/Forming Cut

"D"

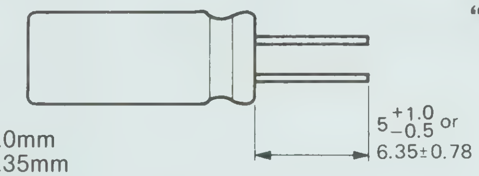


*3.5±0.5 mm is available for case dia. ϕ4.

Case dia. of ϕ10 to ϕ18 and 3479 Type (ϕ22 to ϕ30) Unit (mm)

C/Cut

"C"
"H"

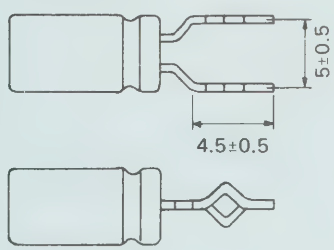


C=5.0mm
H=6.35mm

Case dia. of ϕ5 to ϕ8 Unit (mm)

FM/Snap-in Forming Cut

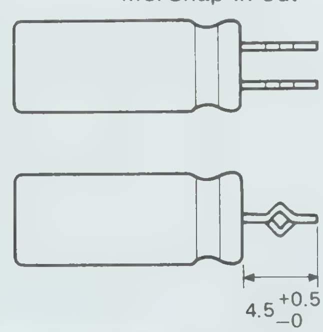
"F"



Case dia. of ϕ10 to ϕ18 Unit (mm)

MC/Snap-in Cut

"M"



PRODUCT LABEL SPECIFICATION

Philips Components Capacitors are marked with:

- Nominal Capacitance
- Rated Voltage
- Series Code Number
- Polarity
- PHILIPS
- Country of Origin
- Special Tolerances

Series Code Numbers and Sleeve/Marking Colors are as follows:

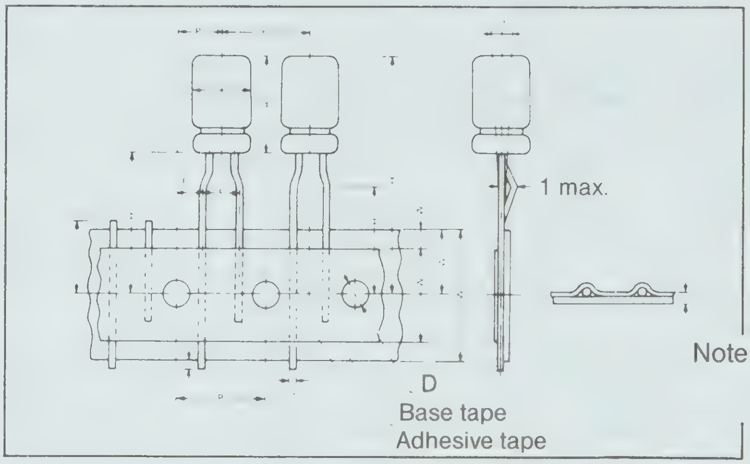
SERIES	SERIES CODE	COLOR
3476–STD	035 01	Blue/Black
3476–Solvent Proof	086 01	Blue/Red
3480	090 01	Dark Brown/White
3481	089 01	Orange/Black
3480–Solvent Proof	095 01	Dark Brown/Yellow (Green)
3481–Solvent Proof	094 01	Orange/Red

Application Guidelines

Plug-in Axial and Radial Lead Types

TAPING

(8mm diameter & smaller)



Note: The component can be oriented on the tape with either positive or negative lead leading. Customer must specify.

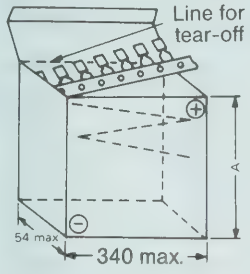
DIMENSIONS (mm)

Item	Symbol	Nominal value	Tolerance	Remarks
Body diameter	D	ϕ4 to ϕ8	±0.5	
Lead-wire diameter	d	0.45/0.5/0.6	±0.05	
Pitch of component	P	12.7	±1.0	
Feed hole pitch	P_0	12.7	±0.2	(Cumulative pitch error: 1mm/20 pitch)
Hole center to lead	P_1	3.85	±0.7	To be measured at bottom of clinch
Feed hole center to component center	P_2	6.35	±1.0	
Lead to lead distance	F	5.0	−0.2/+0.8	
Component alignment, F-R	$\triangle$H	0	±2.0	
Tape width	W	18.0	−0.5	
Hole-down tape width	W_0	12.5	min.	
Hole position	W_1	9.0	−0.5/+0.75	
Hole-down tape position	W_2	1.5	max.	
Height of component from tape center	H	18.5 (ϕ5, ϕ6.3) 20.0 (ϕ8)	±0.75	$H + A \leq H_1$
Lead-wire clinch height	H_0	16.0	±0.5	
Component height	H_1	32.25	max.	Applicable to reel pack box
Lead-wire protrusion	ℓ	1.0	max.	
Feed hole diameter	D_0	4.0	±0.3	
Total tape thickness	t	0.7	±0.2	
Length of snipped lead	L	11.0	max.	

*For D=8, H=20.0±0.75 is available. In this case, the dimension of H_1 is not specified.

PACKAGING

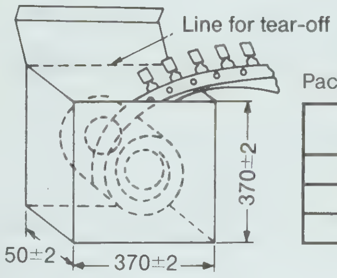
AMMO PACK BOX



Packaging quantity

Dia. of capacitor	Packaging quantity	Dimension "A"
5 mm	2000 pcs.	265
6.3	2000	305
8	1000	265

REEL PACK BOX



Packaging quantity

Dia. of capacitor	Packaging quantity
5 mm	1500 pcs.
6.3	1000
8	800

Note) The component shall be oriented on the tape so that the positive lead is leading or the negative lead is leading, whichever customer request.

METRIC CONVERSION TABLE

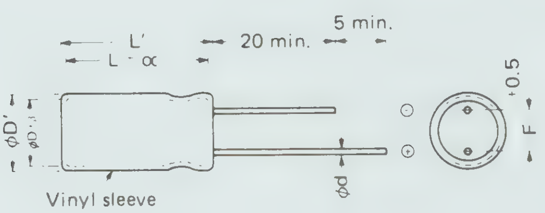
UNINSULATED CASE DIMENSIONS

Case Dimensions		Fig. A	Lead Dia.
Dia. mm	Length mm	F mm	mm
5	11	2	0.5
6.3	11	2.5	0.6
8	11.5	3.5	0.6
10	12.5	5.0	0.6
10	16	5.0	0.6
10	16.5	5.0	0.6
10	20	5.0	0.6
10	20.5	5.0	0.6
12.5	20	5.0	0.6
12.5	20.5	5.0	0.6
12.5	24.5	5.0	0.6
12.5	25	5.0	0.6
12.5	42.5	5.0	0.6
16	25	7.5	0.8
16	31.5	7.5	0.8
16	35.5	7.5	0.8
18	35.5	7.5	0.8
18	40	7.5	0.8

Case Dimensions		Fig. A	Lead Dia.
Dia. Inches	Length Inches	F Inches	Inches
.197	.433	.079	.020
.248	.433	.098	.024
.315	.453	.138	.024
.394	.492	.197	.024
.394	.630	.197	.024
.394	.650	.197	.024
.394	.787	.197	.024
.394	.507	.197	.024
.492	.787	.197	.024
.492	.807	.197	.024
.492	.965	.197	.024
.492	.984	.197	.024
.492	1.673	.197	.024
.630	.984	.295	.032
.630	1.240	.295	.032
.630	1.398	.295	.032
.709	1.398	.295	.032
.709	1.575	.295	.032

CASE OUTLINE DRAWING DIMENSIONS (mm)

FIG. A



Series	D	φ5	φ6.3	φ8	φ10	φ12.5	φ16	φ18
3476	L'	L+1.5					L+2.0	
	D'	D+0.5					D+0.5	
3480	d	0.5	0.6	0.6	0.6	0.6	0.8	0.8
	F	2	2.5	3.5	5	5	7.5	7.5
3481	L'			L+2.0				
	D'			D+1.0				

Conversions of mm to inches for any dimensions not shown on the Conversion Table can be done by dividing mm by 25.4.

Summary of JIS C5141/C5102

Scope

This standard specifies the characteristics, ratings, and dimensions of polarized, aluminum-foil, dry-type electrolytic capacitors for electronic equipment, based on JIS C5140—General Rules for Electrolytic Capacitors, mainly to be used in DC circuits.

The testing method shall comply with JIS C5102—Methods for Testing of Fixed Capacitors for Electronic Equipment.

Table 1

No.	Item			Performance Characteristic C	B	E	A	W		Testing method (JIS C5102)	Summary of testing method in JIS C5102
1	Range of operating temperature °C			−40 ~ +85	−25 ~ +85	−25 ~ +70	−10 ~ +85	−25 ~ +70			
2	Range of rated voltage V			6.3~450				100~450	63~100 (excl.)		
3	Construction and dimensions			To comply with Figs. and Tables						To comply with 6.1 and 6.3	Appearance by visual Dimensions by either caliper or micrometer
4	Marking		Marked items	To satisfy 3						To comply with 6.2	Marking by visual
			Solvent resistance	To be easily readable						To comply with 6.2.1 Reagent to be acetone	Immersed & stationary in reagent at 20 to 25°C for 30±5 seconds
5	Leakage Current μA	CV product 1000 or under	Grade X	0.05CV+10			N/A				Precondition for 30 minutes at rated voltage at 20-25°C, 24-48 hours prior to measurement. VOLTAGE: Rated Voltage TIME: 5 minutes after the voltage has reached the rated value. PROTECTIVE SERIES RESISTOR: About 1,000 ohms.
			Grade Y	0.1CV+60			0.1CV +160		0.06CV +10		
		CV product over 1000	Grade X	0.03CV+30			N/A				
			Grade Y	0.06CV+100			0.06CV +200		0.04CV +30		
6	Tolerance on capacitance %	Nominal capacitance 4.7 μF or under	Rated voltage 6.3V or over up to 100V (excl.)	−10~+150						To comply with 7.4. Measuring circuit to comply with Fig. 6C Measuring frequency 120Hz=10% The peak of measuring voltage not to exceed the rated voltage.	
			Rated voltage 100V or over up to 350V (incl.)	−10~+100							
			Rated voltage over 350V	−10~+75							
		Nominal capacitance over 4.7 μF	Rated voltage 6.3V or over up to 100V (excl.)	−10~+100			−10~+150				
			Rated voltage 100V or over up to 350V (incl.)	−10~+75			−10~+100				
			Rated voltage over 350V	−10~+50							
7	Tangent of loss angle[2]	Rated voltage up to 10V (incl.)		0.5 max.						To comply with 7.5. Test method of No. 6 applies.	
		Rated voltage over 10V up to 25V (incl.)		0.35 max.							
		Rated voltage over 25V up to 63V (incl.)		0.25 max.							
		Rated voltage 63V up to 315V (incl.)		0.2 max.							
		Rated voltage over 315V		0.25 max.							

Summary of JIS C5141/C5102

Table 1 Continued

No.	Item		Performance Characteristic: C, B, E	Performance Characteristic: A, W	Testing method (JIS C5102)	Summary of testing method in JIS C5102
8	Surge voltage	Leakage current	Not to exceed value given in No. 5		To comply with 7.10.[3] Testing temperature for characteristics C, B and E. maximum operating temperature ±2°C: for characteristics A and W. 15 to 35°C.	Precondition per No. 5 above prior to Surge Test. Test conditions are: VOLTAGE: Surge voltage specified in the individual standard. SERIES PROTECTIVE RESISTOR: About 1,000 ohms. Voltage applied 1,000 times for 30±5 seconds at intervals of 5±0.5 minutes without discharging.
		Capacitance	Not less than 85% of the value before test	Not less than 80% of the value before test		
		Tangent of loss angle	Not to exceed 175% of the value given in No. 7	Not to exceed 200% of the value given in No. 7		
		Appearance	No notable change to be found			
9	Withstand voltage[4]		No flashover, dielectric breakdown to take place		To comply with 7.1 To apply 1500V (1000V for rated voltage less than 300V) for 1 minute between the case and mounting fittings.	
10	Insulation resistance[4]		Not less than 10 MΩ		To comply with 7.2 Measurement to be made between the case and mounting fittings with a 500V insulation resistance tester.	
11	Terminal strength	Tensile strength	No breaking or loosening of terminal		To comply with 8.1. Test condition (A) Duration of load Application 10=1 sec.	Lead Wire Terminal Dm. (mm) / Load (kg): 0.3 thru 0.5 — 0.5; >0.5 thru 0.8 — 1.0; >0.8 thru 1.2 — 2.5; >1.2 — 4.5
		Bending strength				
12	Vibration resistance	Capacitance	Measured values to remain stable during measurement (when measured several times within 30 minutes before the end of the test)		To comply with 8.2. class (A). Vibration to be applied for 2 hours each in the directions parallel and perpendicular to the longitudinal axis of the capacitor. Total 4 hours.	VIBRATION FREQUENCIES. 10 to 55 to 10Hz. in 1 minute. Simple harmonic motion. TOTAL AMPLITUDE: 1.5mm
		Appearance	No notable change to be found			
13	Solder-dip heat resistance	Leakage current	Not more than value given in No. 5		To comply with 8.3. Temperature of solder 350±10°C, dipping time 3±0.5 seconds.	The depth of dipping the terminal in flux and solder shall be up to 4±0.8mm from the roof of the terminal, unless otherwise specified.
		Variation of capacitance	Within ±10% of the value before test			
		Tangent of loss angle	Not more than value given in No. 7			
		Appearance	No notable change to be found			
14	Solderability		A minimum of 75% of the terminal surface must be covered with solder.		To comply with 8.4. Temperature of solder 230±5°C. dipping time 2±0.5 seconds.	FLUX. Methanol and solution of rosin to be used OBSERVATION: It shall take place after dipping OBSERVATION INSTRUMENT. Projector or magnifying glass with the magnification of about 10.
15	Stability at low temperature and high temperature	Step 2 — Impedence ratio	Ratio to value in Step 1 to be not more than value given in Table 2		To comply with 9.11. Measurement of impedance to comply with 7.7. Measuring frequency 120Hz±10%.	See Table 3
		Step 4 — Variation of capacitance — Rated voltage 160V or under	Within ±25% of value in Step 1			
		Step 4 — Variation of capacitance — Rated voltage over 160V	Within ±20% of value in Step 1			
		Step 4 — Tangent of loss angle	Not more than value given in No. 7			
		Step 5 — Leakage current	Not more than value given in No. 5			
		Step 5 — Variation of capacitance	Within ±11% of value in Step 1			
		Step 5 — Tangent of loss angle	Not more than value given in No. 7			

Summary of JIS C5141/C5102

Table 1 Continued

<table>
<tr><th rowspan="3">No.</th><th rowspan="3" colspan="3">Item</th><th colspan="5">Performance</th><th rowspan="3">Testing method (JIS C5102)</th><th rowspan="3">Summary of testing method in JIS C5102</th></tr>
<tr><th colspan="5">Characteristic</th></tr>
<tr><th>C</th><th>B</th><th>E</th><th>A</th><th>W</th></tr>
<tr><td rowspan="5">16</td><td rowspan="5">Temperature and immersion cycle</td><td colspan="2">Leakage current</td><td colspan="3">Not more than value given in No. 5</td><td colspan="2" rowspan="5">N/A</td><td rowspan="5">Temperature Cycle per 9.3 follow immediately by Immersion Test per 9.4. Wash with water, dry at room temperature for 1 to 4 hours.
Voltage condition per No. 5 above.
Make measurements.</td><td rowspan="5">IMMERSION CYCLE:
(2) cycles in (2) baths
First bath clean water at 65°±5°C for 15 minutes followed by 0°±3°C saturated salt water bath for 15 minutes.</td></tr>
<tr><td rowspan="2">Variation of capacitance</td><td>Rated voltage 160V or under</td><td colspan="3">Within ±15% of value before test</td></tr>
<tr><td>Rated voltage over 160V</td><td colspan="3">Within ±10% of value before test</td></tr>
<tr><td colspan="2">Tangent of loss angle</td><td colspan="3">Not more than value given in No. 7</td></tr>
<tr><td colspan="2">Appearance</td><td colspan="3">No notable change to be found</td></tr>
<tr><td rowspan="5">17</td><td rowspan="5">Moisture resistance (steady state)</td><td colspan="2">Leakage current</td><td colspan="5">Not more than value given in No. 5</td><td rowspan="5">To comply with 9.5.
Test conducted at no load
Test time, characteristics C, B and E, Grade X 500±12 h
Grade Y, 240±8 h
A and W, 120±6 h
After completion of test. voltage condition per No. 5 above. Then measurements to be made.</td><td rowspan="5">TEMPERATURE:
40±2°C
RELATIVE HUMIDITY
90 to 95%.
NO VOLTAGE SHALL BE APPLIED</td></tr>
<tr><td rowspan="2">Variation of capacitance</td><td>Rated voltage 160V or under</td><td colspan="5">Within ±15% of value before test</td></tr>
<tr><td>Rated voltage over 160V</td><td colspan="5">Within ±10% of value before test</td></tr>
<tr><td colspan="2">Tangent of loss angle</td><td colspan="5">Not more than value given in No. 7</td></tr>
<tr><td colspan="2">Appearance</td><td colspan="5">No notable change to be found</td></tr>
<tr><td>18</td><td colspan="3">Reduced pressure</td><td>No flash-over, dielectric breakdown, swelling or breaking of case, leakage of electrolyte to take place</td><td colspan="4">N/A</td><td>To comply with 9.8.
Air pressure 113±5 mbar.
DC voltage equal to rated voltage to be applied for 1 minute.</td><td></td></tr>
<tr><td rowspan="4">19</td><td rowspan="4">High temperature loading</td><td colspan="2">Leakage current</td><td colspan="5">Not more than value given in No. 5</td><td rowspan="4">To comply with 9.10.3
Test temperature maximum operating temperature ±2°C
Test time: characteristics C, B and E,
Grade X, 200±12 hours
Grade Y, 1000±12 hours
A and W, 500±12 hours
Applied voltage DC voltage equal to rated voltage to be applied through series protective resistor (about 1000)
For Grade X, maximum permissible ripple current to be passed through capacitor.</td><td rowspan="4"></td></tr>
<tr><td colspan="2">Capacitance</td><td colspan="3">Not less than 85% of value before test</td><td colspan="2">Not less than 80% of value before test</td></tr>
<tr><td colspan="2">Tangent of loss angle</td><td colspan="3">Not more than 175% of value given in No. 7</td><td colspan="2">Not more than 200% of value given in No. 7</td></tr>
<tr><td colspan="2">Appearance</td><td colspan="5">No notable change to be found</td></tr>
</table>

Table 2

Rated voltage V	Impedance ratio (Z_T/Z_{20}) Charactistic C	Characteristics B, E, A and W (less than 100V)	Characteristic W (100V to 450V)
3.15 to 6.3 (incle.)	60	8	–
6.13 to 315 (incle.)	16	4	12
315 to 350 (incle.)	40	8	24
350 to 450 (incle.)	80	20	60

Remarks 1. Z_T: impedance (Ω) at the lowest operating temperature
2. Z_{20}: impedance (Ω) at 120°C
3. Measuring frequency to be 120Hz±10%

Table 3

Step	Temperature °C	Time min.
1	Minimum working temperature $^{0}_{-3}$	30
2	Room temperature	10–15
3	Maximum working temperature $^{+3}_{0}$	30
4	Room temperature	10–15

Ceramic Capacitors
QUICK REFERENCE INDEX

Ceramic Leaded Capacitors

Series	Description	Capacitance Range	Working Voltage Range (VDC)	Page
A	MonoAxial™ MULTILAYER Conformal Coated Axial Leaded	10 pf to 1.0 μF	up to 200VDC	132
G	Mono-Glass™ MULTILAYER Glass Encapsulated Axial Leaded	10 pf to .56 μF	up to 200VDC	136
K	Mono-Kap™ MULTILAYER Radial Leaded	10 pf to 10 μF	up to 200VDC	142
P	Mono-Pak™ MULTILAYER Dual In-Line Package	10 pf to .33 μF	up to 200VDC	158
R	General Purpose and Temperature Stable Single Plate Caps	1.0 pf to .022 μF	30VDC and 100VDC	190

Ceramic Disc Capacitors

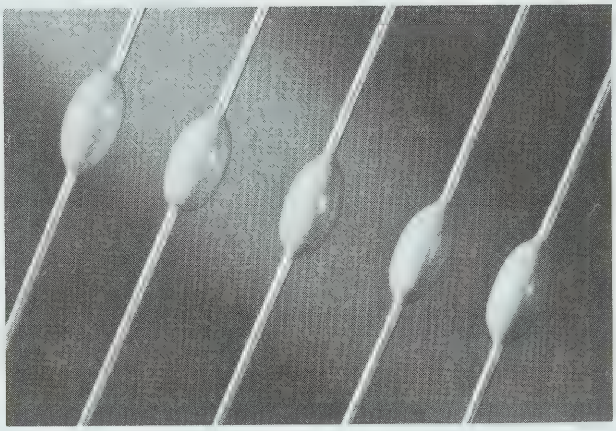
Series	Description	Capacitance Range	Working Voltage Range	Page
D & S	General Purpose and Temperature Stable Class 1,2 & 3	1.0 pf to .1 μF	50VDC to 6KVDC	162
S	Circuit Protection GAP-KAP®	.75 pf to .02 μF	up to 3000VDC; Up to 6KVDC APO	179
S-UL	UL / VDE / CSA AC Rated Discs	100 pf to .01 μF	125VAC, 250VAC, and 400VAC	181
U	Ultra-Kap® Class IV	.01 μf to 2.2 μF	3VDC to 100VDC	184

RF Transmitting Capacitors

Series	Description	Capacitance Range	Working Voltage Range (VDC)	Page
T	RF Rated, Special Application Transmitting Capacitors	3.0 pf to .001 μF	5KV, 7.5KV, 15KV and 20KVDC	196

SERIES A

Mono-Axial™ Conformal Coated Ceramic Capacitors



DESCRIPTION

Industry requirements for components utilized in automated assembly and placement equipment have significantly expanded application opportunities for automatic insertion of multilayer ceramic capacitors. These devices enable the electronic manufacturer and assembler to increase the printed circuit board density and allow use of both sides of the board for greater productivity.

Class I dielectrics (C0G or NPO) have a stable, predictable, linear change over their operating temperature range and typically are neither Voltage nor Frequency sensitive. Class II and Class III dielectrics (X7R and Z5U, respectively) typically are used for bypass and coupling applications, where their sensitivity to Voltage and Frequency may be tolerated. Their Temperature Characteristics are non-linear and may best be described as a maximum tolerance envelope over a rated temperature range.

MECHANICAL PARAMETERS:

Terminal Strength: 2.2 Kg (5 lbs) Minimum pull to destruction, per Method B5 of RS-198-CII, Test Condition A.

Lead Materials: #24 AWG (.020″ ±0.001″) Tinned, Copper Clad Steel. 30% Conductivity. Temper: Soft; Tensile Strength: 65000 PSI Max.

Body: Conformally coated Epoxy.

ELECTRICAL PARAMETERS:

Capacitance: Measured @ 1Mhz @ 1.0±0.2 VRMS @ 25°C for C0G types with C≤ 1000pF. Measured @ 1Khz @ 1.0±0.2 VRMS @ 25°C for C0G types with C> 1000pF. Measured @ 1Khz @ 1.0VRMS ± .2VRMS @ 25°C for X7R types. Measured @ 1Khz @ 0.5VRMS ±.1VRMS @ 25°C for Z5U types.

Dissipation Factor: .1% Maximum for C0G types, 2.5% Maximum for X7R types and 4.0% for Z5U types; Measurement conditions are the same as for Capacitance measurement.

Dielectric Strength: Parts are subjected for up to 5 seconds @ 25°C to 250% of Rated Voltage and will exhibit no evidence of breakdown.

Insulation Resistance: When measured @ 25°C and Rated Voltage, the following Minimum Values will be met: 100K MegΩ or 1000ΩF (whichever is less) for C0G and X7R types, 10K MegΩ or 1000 ΩF (whichever is less) for Z5U types.

Body Insulation: 500VDC Minimum, in accordance with RS-198-CII.

Operating Temperature Range: −55°C to +125°C for C0G, −55°C to +125°C for X7R, −55°C to +85°C for Z5U.

Packaging: Mono-Axial parts are supplied in tape and reel and form per EIA RS-296.

Mono-Axial™ Conformal Coated Ceramic Capacitors

A 104 M 17 Z5U F VV WN

A — A Mono-AXIAL Product Line

104 — **CAPACITANCE VALUE**
First two digits are significant, third digit is a multiplier as follows:
0 x 1
1 x 10
2 x 100
3 x 1000
4 x 10000
5 x 100000

M — **Tolerance Code:**
J ±5% (C0G Only)
K ±10% (C0G and X7R)
M ±20% (X7R and Z5U)
P +100/−0% (Z5U)
Z +80/−20% (Z5U)

17 — **Size Code:**
17 .170"Long, .100"Dia.
18 .170"Long, .120"Dia.
26 .260"Long, .120"Dia.
29 .290"Long, .150"Dia.
40 .400"Long, .150"Dia.

Z5U —
C0G 0PPM±30PPM from −55°C to +125°C
X7R ±15% Max Cap change from −55°C to +125°C.
Z5U +22 to −56% Max Cap change from +10°C to +85°C.

Note: 1 inch = 25.4 mm

F —
F 50VDC C0G, X7R, Z5U
H 100VDC C0G, X7R Z5U
K 200VDC C0G, X7R

VV —
VV Taped & Reeled per EIA RS296D Class 1 5K Reel 17/18, 26Size 2.5K Reel 29 & 40Size .020" Dia Tin Plated CCS Wire Leads
VY Taped & Reeled per EIA RS296D Class 1 1K Reel All Sizes .020" Dia Tin Plated CCS Wire Leads

WN —

Cap Value in Mfd.	Min. IR in MegΩ	Detail Code
≤ .01	100000	WA
.012	84000	WB
.015	67000	WC
.018	56000	WD
.022	46000	WE
.027	37000	WF
.033	31000	WG
.039	26000	WH
.047	22000	WJ
.056	18000	WK
.068	15000	WL
.082	12000	WM
.100	10000	WN
.120	8400	WP
.150	6700	WR
.180	5600	WS
.220	4600	WT
.27	3700	WU
.33	3100	WW
.39	2600	WX
.47	2200	WY
.56	1800	XA
.68	1500	XB
.82	1200	XC
1.0	1000	XD

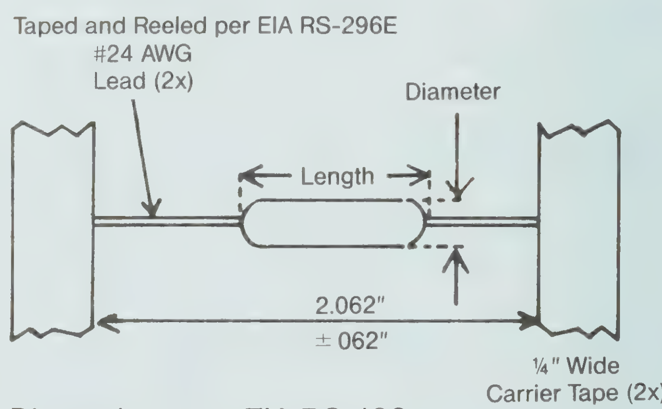
SERIES A

Mono-Axial™ Conformal Coated Ceramic Capacitors

MONO-AXIAL RANGE CHARTS AND SIZE CODES:

Material	C0G			X7R			Z5U	
Voltage	50V	100V	200V	50V	100V	200V	50V	100V
Cap. Value								
10 pF	17	17	17					
12 pF	17	17	17					
15 pF	17	17	17					
18 pF	17	17	17					
22 pF	17	17	17					
27 pF	17	17	17					
33 pF	17	17	17					
39 pF	17	17	17					
47 pF	17	17	17					
56 pF	17	17	17					
68 pF	17	17	17					
82 pF	17	17	17					
100 pF	17	17	17					
120 pF	17	17	17					
150 pF	17	17	17					
180 pF	17	17	17					
220 pF	17	17	17	17	17	17		
270 pF	17	17	17	17	17	17		
330 pF	17	17	26	17	17	17		
390 pF	17	17	26	17	17	17		
470 pF	17	17	26	17	17	17		
560 pF	17	17	26	17	17	17		
680 pF	17	26	26	17	17	17		
820 pF	17	26	26	17	17	17		
.001 μF	17	26	26	17	17	17		
.0012 μF	26	26	40	17	17	17		
.0015 μF	26	26	29	17	17	17		
.0018 μF	26	26	29	17	17	17		
.0022 μF	26	29	40	17	17	17		
.0027 μF	29	40	40	17	17	17		
.0033 μF	29	40		17	17	17		
.0039 μF	40	40		17	17	17		
.0047 μF				17	17	26		
.0056 μF				17	17	26		
.0068 μF				17	17	26		
.0082 μF				17	17	26		

Material	C0G			X7R			Z5U	
Voltage	50V	100V	200V	50V	100V	200V	50V	100V
Cap. Value								
.01 μF				17	17	26	17	17
.012 μF				17	17	26	17	17
.015 μF				17	17	26	17	17
.018 μF				17	17	26	17	17
.022 μF				17	17	26	17	17
.027 μF				17	26	29	17	17
.033 μF				17	26	29	17	26
.039 μF				17	26	29	17	26
.047 μF				17	26	29	17	26
.056 μF				17	26	40	17	26
.068 μF				18	26	40	17	26
.082 μF				18	26		17	26
.1 μF				18	29		17	26
.12 μF				26	29		17	29
.15 μF				26	29		18	29
.18 μF				26	40		18	29
.22 μF				40			18	40
.27 μF				40			18	40
.33 μF				40			18	
.39 μF							40	
.47 μF							40	
.56 μF							40	



Standard Tolerances:
C0G ±5%; ±10% also available
X7R ±10%; ±20% also available
Z5U +80/−20%; ±20% also available.

Dimensions per EIA RS-198:

Size	Length	Diameter
17	.170″ Max	.100″ Max
18	.170″ Max	.120″ Max
26	.260″ Max	.120″ Max
29	.290″ Max	.150″ Max
40	.400″ Max	.150″ Max

Note:
"Length is defined per EIA RS-198C"

Mono-Axial™ Conformal Coated Ceramic Capacitors

STANDARD STOCKED PARTS
OTHER PART TYPES AVAILABLE—
CONSULT FACTORY

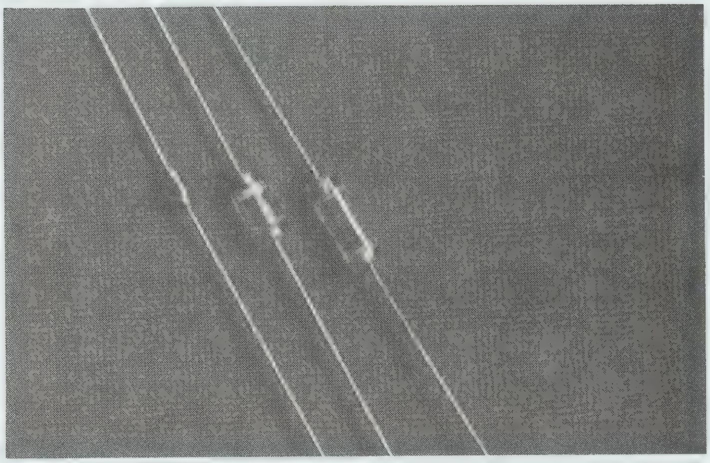
CAP.	CATALOG PART NUMBER	DIST. PART NUMBER	CAP. TOL.	SIZE CODE
MONOAXIAL™ 50 Volt DCW C0G (NPO)				
10pf	A100J17C0GHVVWA	A40A100J	± 5%	17
15pf	A150J17C0GHVVWA	A40A150J	± 5%	17
18pf	A180J17C0GHVVWA	A40A180J	± 5%	17
22pf	A220J17C0GHVVWA	A40A220J	± 5%	17
27pf	A270J17C0GHVVWA	A40A270J	± 5%	17
33pf	A330J17C0GHVVWA	A40A330J	± 5%	17
47pf	A470J17C0GHVVWA	A40A470J	± 5%	17
68pf	A680J17C0GHVVWA	A40A680J	± 5%	17
82pf	A820J17C0GHVVWA	A40A820J	± 5%	17
100pf	A101J17C0GFVVWA	A40C101J	± 5%	17
150pf	A151J17C0GFVVWA	A40C151J	± 5%	17
180pf	A181J17C0GFVVWA	A40C181J	± 5%	17
220pf	A221J17C0GFVVWA	A40C221J	± 5%	17
330pf	A331J17C0GFVVWA	A40C331J	± 5%	17
390pf	A391J17C0GFVVWA	A40C391J	± 5%	17
470pf	A471J17C0GFVVWA	A40C471J	± 5%	17
560pf	A561J17C0GFVVWA	A40C561J	± 5%	17
680pf	A681J17C0GFVVWA	A40C681J	± 5%	17
1000pf	A102J17C0GFVVWA	A40C102J	± 5%	17
MONOAXIAL™ 50 Volt DCW X7R				
220pf	A221K17X7RHVVWA	A41A221K	±10%	17
270pf	A271K17X7RHVVWA	A41A271K	±10%	17
330pf	A331K17X7RHVVWA	A41A331K	±10%	17
470pf	A471K17X7RHVVWA	A41A471K	±10%	17
680pf	A681K17X7RHVVWA	A41A681K	±10%	17
820pf	A821K17X7RHVVWA	A41A821K	±10%	17
.001 µf	A102K17X7RHVVWA	A41A102K	±10%	17
.0012 µf	A122K17X7RHVVWA	A41A122K	±10%	17
.0015 µf	A152K17X7RHVVWA	A41A152K	±10%	17
.0022 µf	A222K17X7RHVVWA	A41A222K	±10%	17
.0033 µf	A332K17X7RFVVWA	A41C332K	±10%	17
.0047 µf	A472K17X7RFVVWA	A41C472K	±10%	17
.01 µf	A103K17X7RFVVWA	A41C103K	±10%	17
.015 µf	A153K17X7RFVVWC	A41C153K	±10%	17
.022 µf	A223K17X7RFVVWE	A41C223K	±10%	17
.033 µf	A333K17X7RFVVWG	A41C333K	±10%	17
.047 µf	A473K17X7RFVVWJ	A41C473K	±10%	17
.056 µf	A563K17X7RFVVWK	A41C563K	±10%	17
.1 µf	A104K18X7RFVVWN	A41C104K	±10%	18
MONOAXIAL™ 50 Volt DCW Z5U				
.01 µf	A103M17Z5UFVVWA	A43C103M	±20%	17
.01 µf	A103Z17Z5UFVVWA	A43C103Z	+80, –20%	17
.022 µf	A223M17Z5UFVVWE	A43C223M	±20%	17
.033 µf	A333M17Z5UFVVWG	A43C333M	±20%	17
.047 µf	A473M17Z5UFVVWJ	A43C473M	±20%	17
.047 µf	A473Z17Z5UFVVWJ	A43C473Z	+80, –20%	17
.1 µf	A104M17Z5UFVVWN	A43C104M	±20%	17
.1 µf	A104Z17Z5UFVVWN	A43C104Z	+80, –20%	17
.22 µf	A224M18Z5UFVVWT	A43C224M	±20%	18
.22 µf	A224Z18Z5UFVVWT	A43C224Z	+80, -20%	18
.27 µf	A274Z18Z5UFVVWU	A43C274Z	+80, –20%	18
.33 µf	A334M18Z5UFVVWW	A43C334M	±20%	18
.33 µf	A334Z18Z5UFVVWW	A43C334Z	+80, –20%	18
.47 µf	A474Z40Z5UFVVWY	A43C474Z	+80, –20%	40
.56 µf	A564M40Z5UFVVXD	A43C564M	±20%	40

SERIES G

Mono-glass™ 50VDC and 100VDC, Glass Encapsulated, Multilayer Capacitors

2

Ceramic Capacitors



DESCRIPTION:

Series G Glass Encapsulated capacitors feature reliable hermetically sealed type, glass to metal construction. This durable construction prevents reflow of solderless internal contacts in the wave soldering process and prevents glass fracturing during lead forming.

The Glass Encapsulated capacitors are ideally suited for applications in communications equipment, navigation and guidance systems, computer business machines or where high volume, low price is required.

ELECTRICAL PARAMETERS

CAPACITANCE:

Measured @ 1Mhz @ 1.0±0.2 VRMS @ 25°C for C0G types with C ≤ 1000pF.

Measured @ 1Khz @ 1.0±0.2 VRMS @ 25°C for C0G types with C ≥ 1000pF.

Measured @ 1Khz @ 1.0VRMS ± .2VRMS @ 25°C for X7R types.

Measured @ 1Khz @ .5VRMS ±.1VRMS @ 25°C for Z5U and Y5V types.

DISSIPATION FACTOR:

.1% Maximum for C0G types,
2.5% Maximum for X7R types and
4.0% Maximum for Z5U and Y5V types;
Measurements conditions are the same as for Capacitance measurement.

DIELECTRIC STRENGTH:

Parts are subjected for up to 5 seconds @ 25°C to : 250% of Rated Voltage

INSULATION RESISTANCE:

When measured @ 25°C and Rated Voltage, the following Minimum Values will be met:
100 Gig Ω or 1000 ΩF (whichever is less) for C0G and X7R types, 10 GigΩ or 1000 ΩF (whichever is less) for Z5U and Y5V types.

ENCAPSULATION:

Glass to Metal Seal

OPERATING TEMPERATURE RANGE

−55°C to +125°C for C0G
−55°C to +125°C for X7R
−55°C to +85°C for Y5V and Z5U

Philips Components • 7158 Merchant Avenue • El Paso, TX 79915 • (915) 775-4242 • FAX: (915) 775-4249

Mono-glass Glass Encapsulated Capacitors

G 102 M 17 Z5U F VV WA

G Mono-Glass Product Line

CAPACITANCE VALUE
First two digits are significant, third digit is a multiplier as follows:
0 x 1
1 x 10
2 x 100
3 x 1000
4 x 10000
5 x 100000

Tolerance Code:
J ± 5% (C0G Only)
K ± 10% (C0G and X7R)
M ± 20% (X7R and Z5U)
P +100/−0% (Z50)
Z +80/−20% (Z5U)

Note: Above Numbering System is for STANDARD PRODUCT.

Size Code:
17 .170″ Long, .100″ Dia.
20 .200″ Long, .100″ Dia.
25 .250″ Long, .100″ Dia.
30 .300″ Long, .150″ Dia.
40 .400″ Long, .150″ Dia.

C0G OPPM ± 30PPM from −55°C to +125°C
X7R ± 15% Max Cap change from −55°C to +125°C
Z5U +22 to −56% Max Cap change from +10°C to +85°C

F 50VDC
C0G, X7R, Z5U

H 100VDC
C0G,X7R Z5U

K 200VDC
C0G,X7R

VV Taped & Reeled per EIA RS296D Class 1
5K Reel 17, 20 & 25 Size
2.5K Reel 30 & 40 Size
.020″ Dia. Tin Plated CCS Wire Leads

Note: 1 Inch = 25.4 mm

Cap Value in Mfd.	Min. IR in MegΩ	Detail Code
≤ .01	100000	WA
.012	84000	WB
.015	67000	WC
.018	56000	WD
.022	46000	WE
.027	37000	WF
.033	31000	WG
.039	26000	WH
.047	22000	WJ
.056	18000	WK
.068	15000	WL
.082	12000	WM
.100	10000	WN
.120	8400	WP
.150	6700	WR
.180	5600	WS
.220	4600	WT
.27	3700	WU
.33	3100	WW
.39	2600	WX
.47	2200	WY
.56	1800	XA
.68	1500	XB
.82	1200	XC
1.0	1000	XD
1.5	670	XE
2.2	460	XF
2.7	370	XG
3.3	310	XH
4.7	220	XJ
5.6	180	XK
6.8	150	XL
8.2	120	XM
1.0	100	XN

SERIES G

Mono-glass™ 50VDC and 100VDC, Glass Encapsulated, Multilayer Capacitors

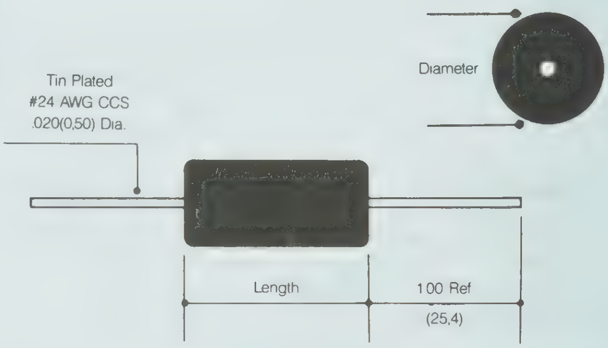
CAPACITANCE RANGE PER BODY SIZE

SIZE	VOLTAGE	C0G TOL 5%, 10% MIN/MAX VAL.	X7R TOL 10%, 20% MIN/MAX VAL.	Z5U TOL 20%, 80/20% MIN/MAX VAL.
17	50V	10/470PF	100PF/.027MFD	.001/.1MFD
	100V	10/390PF	100PF/.012MFD	.001/.022MFD
20	50V	560/680PF	.033MFD	.056/.1MFD
	100V	470PF	.015MFD	.027MFD
25	50V	750/1000PF	.039/.056MFD	.1MFD
	100V	560/820PF	.018/.022MFD	.033/.047MFD
30	50V	1200/3300PF	.068/.18MFD	.12/.33MFD
	100V	1000/2700PF	.027/.082MFD	.056/.15MFD
40	50V	3900/6800PF	.22/.56MFD	.39/.56MFD
	100V	3300/4700PF	.1/.15MFD	.18/.27MFD

Mechanical:

Size Code	Maximum Length Inches	Maximum Length Millimeters	Maximum Diameter Inches	Maximum Diameter Millimeters
17	.170	4,32	.100	2,54
20	.200	5,08	.100	2,54
25	.250	6,36	.100	2,54
30	.300	7,63	.150	3,81
40	.400	10,17	.150	3,81

Note: 1 Inch = 25.4mm



INCH (**MILLIMETER**)

INCH / **MILLIMETER**

STANDARD MARKING (Minimum)

Capacitance Value:

- 10pF through 99pF: actual value in pF (2 digits only)
- 100pF and above: coded cap. value, same as used in P/N

Tolerance Code; Standard EIA Tolerance Code.

Material Code (EIA TC CODE): A = C0G, C = X7R, E = Z5U, Y = Y5V

Date Code: four digit code, first two digits denote year, last two the week of manufacture.

PACKAGING:

Standard Product of Size Code 17, 20 and 25 is Reel-packed per EIA RS-296; 5000 pcs per reel.

Standard Product of Size Code 30 and 40 is Reel-packed per EIA RS-296; 2500 pcs per reel.

Mono-glass™ 50VDC and 100VDC, Glass Encapsulated, Multilayer Capacitors

STANDARD STOCK LISTING

CAP.	PART NUMBER	DIST. PART NUMBER	CAP. TOL.	SIZE CODE
50 Volt DCW C0G (NPO)				
10 pf	G100J17C0GFVVWA	C40C100J	± 5%	17
10 pf	G100K17C0GFVVWA	C40C100K	± 10%	17
12 pf	G120J17C0GFVVWA	C40C120J	± 5%	17
15 pf	G150J17C0GFVVWA	C40C150J	± 5%	17
15 pf	G150K17C0GFVVWA	C40C150K	± 10%	17
18 pf	G180J17C0GFVVWA	C40C180J	± 5%	17
22 pf	G220J17C0GFVVWA	C40C220J	± 5%	17
22 pf	G220K17C0GFVVWA	C40C220K	± 10%	17
27 pf	G270J17C0GFVVWA	C40C270J	± 5%	17
33 pf	G330J17C0GFVVWA	C40C330J	± 5%	17
39 pf	G390J17C0GFVVWA	C40C390J	± 5%	17
47 pf	G470J17C0GFVVWA	C40C470J	± 5%	17
47 pf	G470K17C0GFVVWA	C40C470K	± 10%	17
56 pf	G560J17C0GFVVWA	C40C560J	± 5%	17
68 pf	G680J17C0GFVVWA	C40C680J	± 5%	17
68 pf	G680K17C0GFVVWA	C40C680K	± 10%	17
82 pf	G820J17C0GFVVWA	C40C820J	± 5%	17
82 pf	G820K17C0GFVVWA	C40C820K	± 10%	17
100 pf	G101J17C0GFVVWA	C40C101J	± 5%	17
100 pf	G101K17C0GFVVWA	C40C101K	± 10%	17
120 pf	G121J17C0GFVVWA	C40C121J	± 5%	17
150 pf	G151J17C0GFVVWA	C40C151J	± 5%	17
180 pf	G181J17C0GFVVWA	C40C181J	± 5%	17
220 pf	G221J17C0GFVVWA	C40C221J	± 5%	17
220 pf	G221K17C0GFVVWA	C40C221K	± 10%	17
270 pf	G271J17C0GFVVWA	C40C271J	± 5%	17
330 pf	G331J17C0GFVVWA	C40C331J	± 5%	17
390 pf	G391J17C0GFVVWA	C40C391J	± 5%	17
390 pf	G391K17C0GFVVWA	C40C391K	± 10%	17
470 pf	G471J17C0GFVVWA	C40C471J	± 5%	17
470 pf	G471K17C0GFVVWA	C40C471K	± 10%	17
560 pf	G561J17C0GFVVWA	C40C561J	± 5%	17
680 pf	G681J17C0GFVVWA	C40C681J	± 5%	17
820 pf	G821J25C0GFVVWA	–	± 5%	25
.001 μf	G102J25C0GFVVWA	–	± 5%	25
.001 μf	G102K25C0GFVVWA	–	± 10%	25
.0012 μf	G122J30C0GFVVWA	–	± 5%	30
.0015 μf	G152J30C0GFVVWA	–	± 5%	30
.0018 μf	G182J30C0GFVVWA	C40C182J	± 5%	30
.0022 μf	G222J30C0GFVVWA	C40C222J	± 5%	30
.0027 μf	G272J30C0GFVVWA	C40C272J	± 5%	30
.0027 μf	G272K30C0GFVVWA	C40C272K	± 10%	30
.0033 μf	G332J30C0GFVVWA	C40C332J	± 5%	30
.0033 μf	G332K30C0GFVVWA	C40C332K	± 10%	30
.0039 μf	G392J40C0GFVVWA	–	± 5%	40
.0047 μf	G472J40C0GFVVWA	–	± 5%	40
.0056 μf	G562J40C0GFVVWA	C40C562J	± 5%	40
.0068 μf	G682J40C0GFVVWA	C40C682J	± 5%	40
.0068 μf	G682K40C0GFVVWA	C40C682K	± 10%	40

SERIES G

Mono-glass™ 50VDC and 100VDC, Glass Encapsulated, Multilayer Capacitors

2

Ceramic Capacitors

STANDARD STOCK LISTING

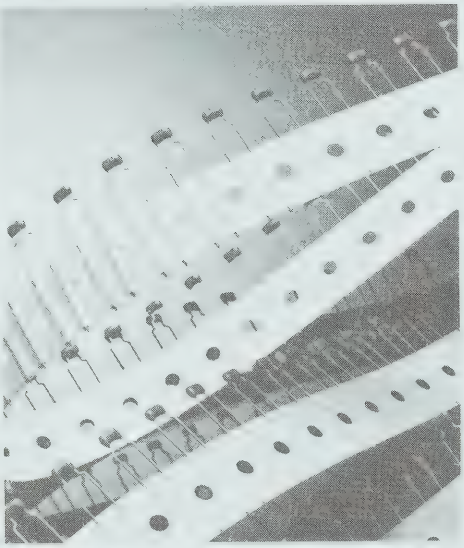
CAP.	PART NUMBER	DIST. PART NUMBER	CAP. TOL.	SIZE CODE
50 Volt DCW X7R				
.15 μf	G154K30X7RFVVWR	C41C154K	± 10%	30
.18 μf	G184K30X7RFVVWS	C41C184K	± 10%	30
.22 μf	G224K30X7RFVVWT	–	± 10%	30
50 Volt DCW Z5U				
.001 μf	G102M17Z5UFVVWA	C43C102M	± 20%	17
.001 μf	G102Z17Z5UFVVWA	C43C102Z	+ 80-20%	17
.0012 μf	G122M17Z5UFVVWA	C43C122M	± 20%	17
.0015 μf	G152M17Z5UFVVWA	C43C152M	± 20%	17
.0018 μf	G182M17Z5UFVVWA	C43C182M	± 20%	17
.0022 μf	G222M17Z5UFVVWA	C43C222M	± 20%	17
.0027 μf	G272M17Z5UFVVWA	C43C272M	± 20%	17
.0033 μf	G332M17Z5UFVVWA	C43C332M	± 20%	17
.0039 μf	G392M17Z5UFVVWA	C43C392M	± 20%	17
.0047 μf	G472M17Z5UFVVWA	C43C472M	± 20%	17
.0056 μf	G562M17Z5UFVVWA	C43C562M	± 20%	17
.0068 μf	G682M17Z5UFVVWA	C43C682M	± 20%	17
.0082 μf	G822M17Z5UFVVWA	C43C822M	± 20%	17
.01 μf	G103M17Z5UFVVWA	C43C103M	± 20%	17
.01 μf	G103Z17Z5UFVVWA	C43C103Z	+ 80-20%	17
.012 μf	G123M17Z5UFVVWB	C43C123M	± 20%	17
.015 μf	G153M17Z5UFVVWC	C43C153M	± 20%	17
.022 μf	G223M17Z5UFVVWE	C43C223M	± 20%	17
.022 μf	G223Z17Z5UFVVWE	C43C223Z	+ 80-20%	17
.027 μf	G273M17Z5UFVVWF	C43C273M	± 20%	17
.033 μf	G333M17Z5UFVVWG	C43C333M	± 20%	17
.033 μf	G333Z17Z5UFVVWG	C43C333Z	+ 80-20%	17
.039 μf	G393M17Z5UFVVWH	C43C393M	± 20%	17
.047 μf	G473M17Z5UFVVWJ	C43C473M	± 20%	17
.047 μf	G473Z17Z5UFVVWJ	C43C473Z	+ 80-20%	17
.056 μf	G563M17Z5UFVVWK	C43C563M	± 20%	17
.068 μf	G683M17Z5UFVVWL	C43C683M	± 20%	17
.068 μf	G683Z17Z5UFVVWL	C43C683Z	+ 80-20%	17
.082 μf	G823M17Z5UFVVWM	C43C823M	± 20%	17
.1 μf	G104M17Z5UFVVWN	C43C104M	± 20%	17
.1 μf	G104Z17Z5UFVVWN	C43C104Z	+ 80-20%	17
.12 μf	G124M30Z5UFVVWP	C43C124M	± 20%	30
.15 μf	G154M30Z5UFVVWR	C43C154M	± 20%	30
.18 μf	G184M30Z5UFVVWS	C43C184M	± 20%	30
.22 μf	G224M30Z5UFVVWT	C43C224M	± 20%	30
.22 μf	G224Z30Z5UFVVWT	C43C224Z	+ 80-20%	30
.27 μf	G274M30Z5UFVVWU	C43C274M	± 20%	30
.33 μf	G334M30Z5UFVVWW	–	± 20%	30
.39 μf	G394M40Z5UFVVWX	–	± 20%	40
.47 μf	G474M40Z5UFVVWY	–	± 20%	40
.47 μf	G474Z40Z5UFVVWY	–	+ 80-20%	40
50 Volt DCW Y5V				
.0047 μf	G472Z17Y5VFVVWA	C42C472Z	+80-20%	17
.01 μf	G103Z17Y5VFVVWA	C42C103Z	+80-20%	17
.047 μf	G473Z17Y5VFVVWJ	C42C473Z	+80-20%	17
.1 μf	G104Z25Y5VFVVWN	C42C104Z	+80-20%	25

Mono-glass™ 50VDC and 100VDC, Glass Encapsulated, Multilayer Capacitors

CAP.	PART NUMBER	DIST. PART NUMBER	CAP. TOL.	SIZE CODE
50 Volt DCW X7R				
100 pf	G101K17X7RFVVWA	C41C101K	± 10%	17
100 pf	G101M17X7RFVVWA	C41C101M	± 20%	17
120 pf	G121K17X7RFVVWA	C41C121K	± 10%	17
150 pf	G151K17X7RFVVWA	C41C151K	± 10%	17
150 pf	G151M17X7RFVVWA	C41C151M	± 20%	17
180 pf	G181K17X7RFVVWA	C41C181K	± 10%	17
220 pf	G221K17X7RFVVWA	C41C221K	± 10%	17
220 pf	G221M17X7RFVVWA	C41C221M	± 20%	17
270 pf	G271K17X7RFVVWA	C41C271K	± 10%	17
330 pf	G331K17X7RFVVWA	C41C331K	± 10%	17
330 pf	G331M17X7RFVVWA	C41C331M	± 20%	17
390 pf	G391K17X7RFVVWA	C41C391K	± 10%	17
470 pf	G471K17X7RFVVWA	C41C471K	± 10%	17
470 pf	G471M17X7RFVVWA	C41C471M	± 20%	17
560 pf	G561K17X7RFVVWA	C41C561K	± 10%	17
680 pf	G681K17X7RFVVWA	C41C681K	± 10%	17
680 pf	G681M17X7RFVVWA	C41C681M	± 20%	17
820 pf	G821K17X7RFVVWA	C41C821K	± 10%	17
.001 µf	G102K17X7RFVVWA	C41C102K	± 10%	17
.001 µf	G102M17X7RFVVWA	C41C102M	± 20%	17
.0012 µf	G122K17X7RFVVWA	C41C122K	± 10%	17
.0015 µf	G152K17X7RFVVWA	C41C152K	± 10%	17
.0015 µf	G152M17X7RFVVWA	C41C152M	± 20%	17
.0018 µf	G182K17X7RFVVWA	C41C182K	± 10%	17
.0022 µf	G222K17X7RFVVWA	C41C222K	± 10%	17
.0022 µf	G222M17X7RFVVWA	C41C222M	± 20%	17
.0027 µf	G272K17X7RFVVWA	C41C272K	± 10%	17
.0033 µf	G332K17X7RFVVWA	C41C332K	± 10%	17
.0039 µf	G392K17X7RFVVWA	C41C392K	± 10%	17
.0047 µf	G472K17X7RFVVWA	C41C472K	± 10%	17
.0047 µf	G472M17X7RFVVWA	C41C472M	± 20%	17
.0056 µf	G562K17X7RFVVWA	C41C562K	± 10%	17
.0068 µf	G682K17X7RFVVWA	C41C682K	± 10%	17
.0082 µf	G822K17X7RFVVWA	C41C822K	± 10%	17
.01 µf	G103K17X7RFVVWA	C41C103K	± 10%	17
.01 µf	G103M17X7RFVVWA	C41C103M	± 20%	17
.012 µf	G123K17X7RFVVWB	C41C123K	± 10%	17
.015 µf	G153K17X7RFVVWC	C41C153K	± 10%	17
.018 µf	G183K17X7RFVVWD	C41C183K	± 10%	17
.022 µf	G223K17X7RFVVWE	C41C223K	± 10%	17
.022 µf	G223M17X7RFVVWE	C41C223M	± 20%	17
.027 µf	G273K17X7RFVVWF	C41C273K	± 10%	17
.033 µf	G333K25X7RFVVWG	C41C333K	± 10%	25
.039 µf	G393K25X7RFVVWH	C41C393K	± 10%	25
.039 µf	G393M25X7RFVVWH	C41C393M	± 20%	25
.047 µf	G473K25X7RFVVWJ	C41C473K	± 10%	25
.047 µf	G473M25X7RFVVWJ	C41C473M	± 20%	25
.056 µf	G563K25X7RFVVWK	C41C563K	± 10%	25
.068 µf	G683K30X7RFVVWL	C41C683K	± 10%	30
.082 µf	G823K30X7RFVVWM	C41C823K	± 10%	30
.1 µf	G104K30X7RFVVWN	C41C104K	± 10%	30
.1 µf	G104M30X7RFVVWN	C41C104M	± 20%	30
.12 µf	G124K30X7RFVVWP	C41C124K	± 10%	30

SERIES K

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC, and 200VDC Multilayer Capacitors



DESCRIPTION:

Series K General Purpose capacitors offer high capacitance, miniature size units for general purpose applications. These miniature multilayer capacitors feature radial leads for convenient printed circuit board installation and a rugged epoxy coating for environmental protection.

These capacitors are ideally suited for a wide range of non-critical general purpose bypass, coupling and filtering applications.

Series K Ultra-Stable capacitors provide maximum capacitance stability over a wide range of environmental conditions, applied voltages and frequencies. The ultra-stable C0G (NPO) temperature characteristic is maintained over the complete operating temperature range of −55°C to +125°C.

These capacitors are ideally suited for RC network, pulse and RF tuned circuit applications where extreme stability is of paramount importance.

Series K Temperature Stable capacitors are reliable temperature stable units with a high ratio of capacitance per unit volume. These miniature size units offer a rugged epoxy coating for environmental protection and radial leads for convenient printed circuit board installation.

These capacitors are designed to provide reliable temperature stable performance over an extremely wide temperature range in bypass, coupling and blocking operations.

ELECTRICAL PARAMETERS:

CAPACITANCE:

Measured @ 1Mhz @ 1.0±0.2 VRMS @ 25°C for C0G types with C ≤ 1000pF.

Measured @ 1Khz @ 1.0±0.2 VRMS @ 25°C for C0G types with C ≥ 1000pF.

Measured @ 1Khz @ 1.0VRMS ±.2VRMS @ 25°C for X7R types.

Measured @ 1Khz @ .5VRMS ±.1VRMS @ 25°C for Z5U and Y5V types.

DISSIPATION FACTOR:

.1% Maximum for C0G types,
2.5% Maximum for X7R types and
4.0% Maximum for Z5U and Y5V types;
Measurements conditions are the same as for Capacitance measurement.

DIELECTRIC STRENGTH:

Parts are subjected for up to 5 seconds @ 25°C to: 250% of Rated Voltage

INSULATION RESISTANCE:

When measured @ 25°C and Rated Voltage, the following Minimum Values will be met: 100 GigΩ or 1000 ΩF (whichever is less) for C0G and X7R types, 10 Gig Ω or 1000 ΩF (whichever is less) for Z5U and Y5V types.

ENCAPSULATION:

Conformal Epoxy

OPERATING TEMPERATURE RANGE:

−55°C to +125° for C0G and X7R
−55°C to +85°C for Y5V and Z5U

Mono-Kap® Multilayer Capacitors

K 104 M 20 Z5U F TT WN

K Mono-Kap Product Line

CAPACITANCE VALUE
First two digits are significant, third digit is a multiplier as follows:
0 x 1
1 x 10
2 x 100
3 x 1000
4 x 10000
5 x 100000

Tolerance Code:
J ± 5% (C0G Only)
K ± 10% (C0G and X7R)
M ± 20% (X7R and Z5U)
P +100/−0% (Z5U)
Z +80/−20% (Z5U)

Size Code:
15 .150"x.150"x.100"Thick
20 .200"x.200"x.125"Thick
30 .300"x.300"x.150"Thick
40 .400"x.400"x.150"Thick
50 .500"x.500"x.200"Thick

C0G OPPM ± 30PPM from −55°C to +125°C
X7R ± 15% Max Cap change from −55°C to +125°C
Z5U +22 to −56% Max Cap change from +10°C to +85°C

F 50VDC C0G, X7R, Z5U
H 100VDC C0G,X7R,Z5U
K 200VDC C0G,X7R

Code	Lead Space	Lead Dia	Lead Length	Form
TP	.100"	.020"	Ho-18MM	Tape & Reel Outside Kink
TR	.200"	.020"	Ho-16MM	Tape & Reel Outside Kink
TT	.200"	.020"	Ho-18MM	Tape & Reel Straight Lead
VA	.100"	.016"	1.00"	Bulk Straight Lead
VB	.100"	.020"	1.00"	Bulk Straight Lead
VC	.200"	.020"	1.00"	Bulk Straight Lead
VD	.250"	.020"	1.00"	Bulk Straight Lead
VE	.300"	.020"	1.00"	Bulk Straight Lead
VF	.375"	.020"	1.00"	Bulk Straight Lead
VG	.375"	.025"	1.00"	Bulk Straight Lead
VH	.400"	.025"	1.00"	Bulk Straight Lead
VJ	.100"	.016"	1.00"	Bulk Outside Kink
VK	.100"	.020"	1.00"	Bulk Outside Kink
VL	.200"	.020"	1.00"	Bulk Outside Kink
VM	.400"	.025"	1.00"	Bulk Outside Kink

Cap Value in Mfd.	Min. IR in MegΩ	Detail Code
≤ .01	100000	WA
.012	84000	WB
.015	67000	WC
.018	56000	WD
.022	46000	WE
.027	37000	WF
.033	31000	WG
.039	26000	WH
.047	22000	WJ
.056	18000	WK
.068	15000	WL
.082	12000	WM
.100	10000	WN
.120	8400	WP
.150	6700	WR
.180	5600	WS
.220	4600	WT
.27	3700	WU
.33	3100	WW
.39	2600	WX
.47	2200	WY
.56	1800	XA
.68	1500	XB
.82	1200	XC
1.0	1000	XD
1.5	670	XE
2.2	460	XF
2.7	370	XG
3.3	310	XH
4.7	220	XJ
5.6	180	XK
6.8	150	XL
8.2	120	XM
1.0	100	XN

Note: 1 Inch = 25.4 mm

Note: Above Numbering System is for STANDARD PRODUCT.

SERIES K

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC and 200VDC, Multilayer Capacitors

MONO-KAP VALUES BY SIZE, VOLTAGE AND CERAMIC:

SIZE	VOLTAGE	C0G TOL 5%, 10% MIN/MAX VAL.	X7R TOL 10%, 20% MIN/MAX VAL.	Z5U TOL 20%, 80/20% MIN/MAX VAL.
15	50V	10/470PF	100PF/.027MFD	.01/.047MFD
	100V	10/390PF	100PF/.012MFD	.01/.022MFD
	200V*	10/180PF	100PF/2700MFD	
20	50V	560/3300PF	.033/ 18MFD	.056/.33MFD
	100V	470/2700PF	.012/.10MFD	.027/.18MFD
	200V*	220/1500PF	.0033/.022MFD	
30	50V	.0039/.15MFD	.22/.82MFD	.39/1.5MFD
	100V	.0033/.012MFD	.12/.47MFD	.22/.82MFD
	200V*	.0018/.0068MFD	.027/.12MFD	
40	50V	.018/.039MFD	1.0/2.2MFD	1.8/4.7MFD
	100V	.015/.039MFD	.56/1.5MFD	1.0/2.7MFD
	200V*	.0082/.022MFDF	.22/.33MFD	
50	50V	.047/.082MFD	2.7/4.7MFD	5.6/10.0MFD
	100V	.047/.068MFD	1.8/2.2MFD	3.3/5.6MFD
	200V*	.027/.047MFD	.47/.68MFD	

*Contact your factory representative for further information.

STANDARD MARKING:

CAPACITANCE VALUE:

10pF through 99pF: actual value in pF (plus tolerance code)

100pF and above: coded cap. value, same as used in P/N on the Spec.

TOLERANCE CODE:

Standard EIA Tolerance Code.

VOLTAGE:

1 = 100VDC, 2 = 200VDC, 5 = 50VDC

MATERIAL CODE (EIA TC CODE):

A = COG, C = X7R, E = Z5U, Y = Y5V

*Note: 15 Size marked with Coded Capacitance Value ONLY

SIZE CHART:

Size Code	W (Max.)	H (Max.)	Thickness (Max.)
15	.150	.150	.100
20	.200	.200	.125
30	.300	.300	.150
40	.400	.400	.150
50	.500	.500	.200

Note: 1 inch = 25.4 mm

Philips Components • 7158 Merchant Avenue • El Paso, TX 79915 • (915) 775-4242 • FAX: (915) 775-4249

MONOKAP TAPE & REEL

RADIAL TAPE AND REEL MECHANICAL P/N CODES:

Size	Spacing	AWG/ Wire Dia	Fig	P/N Code	(MM)	Dim.
15	5MM(.200)	24/.020	A	TT	17/19.5	H
15	2.5MM(.100)	24/.020	D	TP	16+/−.5	Ho
20	5MM(.200)	24/.020	D	TR	16+/−.5	Ho
20	5MM(.200)	24/.020	A	TT	17/19.5	H
20	2.5MM(.100)	24/.020	D	TP	16+/−.5	Ho
30	5MM(.200)	24/.020	D	TR	16+/−.5	Ho
30	5MM(.200)	24/.020	B	TT	17/19.5	H
40	5MM(.200)	24/.020	C	TT	17/19.5	H

Inside Kink also available in 5mm (.200) spacing; consult factory.

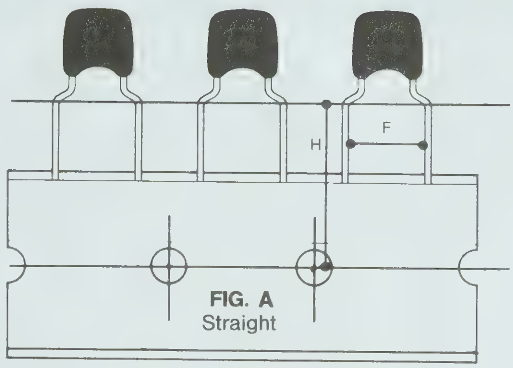


FIG. A
Straight

H/Ho is the dimension from the centerline of the sprocket hole in the tape to the inserted seating plane

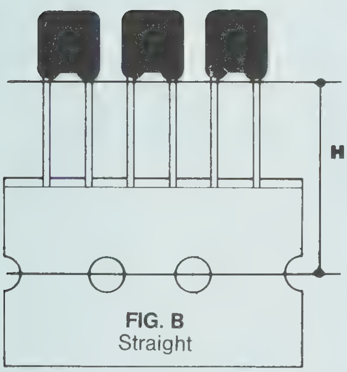


FIG. B
Straight

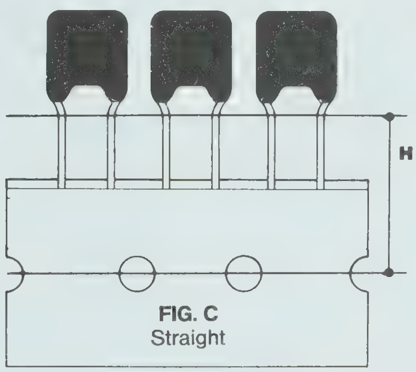


FIG. C
Straight

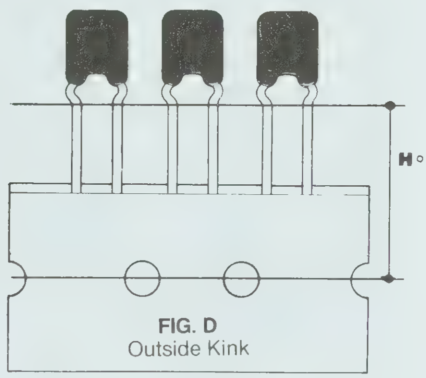


FIG. D
Outside Kink

MONO KAP® TAPE & REEL

Body Dimensions (MK)	L x W	11.0 x 11.0 Max	.43 x .43ref
Body Thickness	T	4.0 Max	.157ref
Wire Lead Dia.	d	0.5+0.06/−0.05	#24 AWG CCS
Taping Pitch	P	12.7 Ref	.500ref
Feed Hole Pitch (Note 1)	Po	12.7±0.3 (Note)	.500ref
Feed Hole Off Alignment	P1/P2	3.85±0.7/6.35±1.3	.15ref/.25ref
Lead Spacing	F	5.0+0.8/−0.2 (or 2.54)	.197ref (.100)
Body Inclination	h	0±1.0	0±.039ref
Carrier Tape Width	W	18.0+1.0/−0.5	.709ref
Adhesive Tape Width	Wo	13.0 Ref	.512ref
Feed Hole Ht off Alignment	W1	9.0+0.75/−0.5	.354ref
Adhesive Tape Margin	W2	3.0+3.0	.118ref
Straight Lead Height	H	17.0Min./19.5Max	.67/.76ref
Lead Crimp Height	Ho	16.0±0.5	.63ref
Top of Component Height	H1	23.0Min/32.25Max	.91/1.27ref
Clean, Parallel Lead Length	H2	6.0ref	.236ref
Lead End Protusion	l	2.0 Max	.078ref
Feed Hole Diameter	Do	4.0±0.3	.157ref
Overall Tape Thickness	t	0.9 Max	.035ref
Rejected Component Cut Height	L	10.0Max	.394ref

Note: 1: Cumulative pitch tolerance over 20 consecutive units not to exceed ±1.0mm.
2: Dimensions meet requirements defined in EIA RS468.
3: "H2" defines the useable portion of the lead for insertion equipment purposes; the leads in this area to be straight and parallel. They shall be @ 90° ±3° to the top edge of the carrier tape and shall also be parallel to each other to within 3°.
Deformation, if any, shall not exceed 3°.
H2 is the straight lead portion of any formed wire and the "Free of coating" area of any non-formed wire.

Note: 1 Inch = 25.4 mm

SERIES K

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC and 200VDC, Multilayer Capacitors

BULK MONO-KAP MECHANICAL P/N CODES.

Size	Spacing	Wire Dia	Figure	P/N Code
15	.100	.016	1	VA
15	.100	.020	1	VB
15	.200	.020	2	VC
15	.100	.016	5	VJ
15	.100	.020	5	VK
20	.100	.020	1	VB
20	.200	.020	2	VC
20	.250	.020	3	VD
20	.300	.020	3	VE
20	.375	.020	3	VF
20	.375	.025	3	VG
20	.100	.020	5	VK
20	.200	.020	5	VL
30	.200	.020	1	VC
30	.300	.020	4	VE
30	.375	.020	3	VF
30	.375	.025	3	VG
30	.200	.020	5	VL
40	.200	.020	4	VC
40	.400	.025	1	VH
40	.200	.020	5	VL
50	.400	.025	1	VH
50	.400	.025	5	VM

Note: 1 Inch = 25.4mm

ELECTRICAL P/N CODES FOR ALL MULTI-LAYER PRODUCTS

Cap Value In μF	Min IR In MΩ	P/N Code	Cap Value In μF	Min IR In MΩ	P/N Code
>=.01	100000	WA	.27	3700	WU
.012	84000	WB	.33	3100	WW
.015	67000	WC	.39	2600	WX
.018	56000	WD	.47	2200	WY
.022	46000	WE	.56	1800	XA
.027	37000	WF	.68	1500	XB
.033	31000	WG	.82	1200	XC
.039	26000	WH	1.0	1000	XD
.047	22000	WJ	1.5	670	XE
.056	18000	WK	2.2	460	XF
.068	15000	WL	2.7	370	XG
.082	12000	WM	3.3	310	XH
.100	10000	WN	4.7	220	XJ
.120	8400	WP	5.6	180	XK
.150	6700	WR	6.8	150	XL
.180	5600	WS	8.2	120	XM
.220	4600	WT	10	100	XN

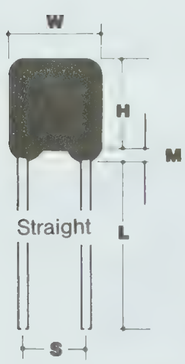


Fig 1 M = .062MAX

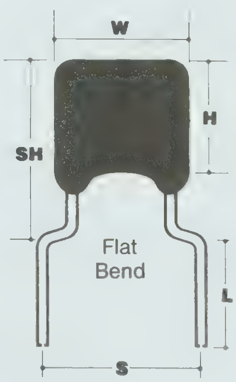


Fig 2

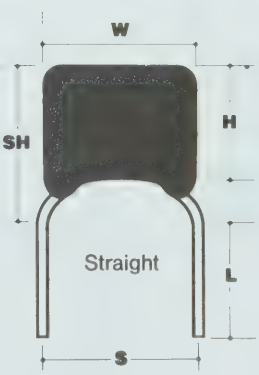


Fig 3

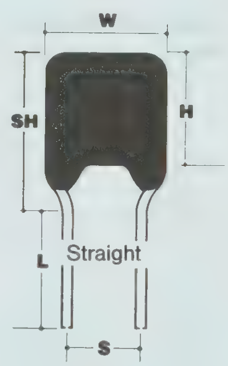


Fig 4

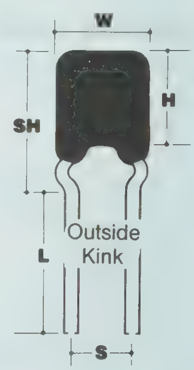


Fig 5 SH = (H Max + .125) Max

Fig 2, 3 & 4 SH = (H Max + .100) Max

For Fig 2, 3, 4, & 5, the meniscus (rundown) will terminate a minimum of .015″ above the Seating Plane (as formed by the wire preform).

Standard Leadlength for Mono-Kap is 1.00″ Min. Cut lead versions available upon request.

.187±.031 recommended as Leadlength below Seating Plane as formed by either wire form or part bottom.

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC and 200VDC, Multilayer Capacitors

STANDARD STOCK LISTING*

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	SIZE CODE	LEAD SPACE
50 Volt DCW C0G (NPO)					
10 pf	K100J15C0GFVAWA	CN15C100J	± 5%	15	.100"
10 pf	K100K15C0GFVAWA	CN15C100K	± 10%	15	.100"
12 pf	K120J15C0GFVAWA	CN15C120J	± 5%	15	.100"
12 pf	K120K15C0GFVAWA	CN15C120K	± 10%	15	.100"
15 pf	K150J15C0GFVAWA	CN15C150J	± 5%	15	.100"
15 pf	K150K15C0GFVAWA	CN15C150K	± 10%	15	.100"
18 pf	K180J15C0GFVAWA	CN15C180J	± 5%	15	.100"
18 pf	K180K15C0GFVAWA	CN15C180K	± 10%	15	.100"
22 pf	K220J15C0GFVAWA	CN15C220J	± 5%	15	.100"
22 pf	K220K15C0GFVAWA	CN15C220K	± 10%	15	.100"
27 pf	K270J15C0GFVAWA	CN15C270J	± 5%	15	.100"
27 pf	K270K15C0GFVAWA	CN15C270K	± 10%	15	.100"
33 pf	K330J15C0GFVAWA	CN15C330J	± 5%	15	.100"
33 pf	K330K15C0GFVAWA	CN15C330K	± 10%	15	.100"
39 pf	K390J15C0GFVAWA	CN15C390J	± 5%	15	.100"
39 pf	K390K15C0GFVAWA	CN15C390K	± 10%	15	.100"
47 pf	K470J15C0GFVAWA	CN15C470J	± 5%	15	.100"
47 pf	K470K15C0GFVAWA	CN15C470K	± 10%	15	.100"
56 pf	K560J15C0GFVAWA	CN15C560J	± 5%	15	.100"
56 pf	K560K15C0GFVAWA	CN15C560K	± 10%	15	.100"
68 pf	K680J15C0GFVAWA	CN15C680J	± 5%	15	.100"
68 pf	K680K15C0GFVAWA	CN15C680K	± 10%	15	.100"
82 pf	K820J15C0GFVAWA	CN15C820J	± 5%	15	.100"
82 pf	K820K15C0GFVAWA	CN15C820K	± 10%	15	.100"
100 pf	K101J15C0GFVAWA	CN15C101J	± 5%	15	.100"
100 pf	K101K15C0GFVAWA	CN15C101K	± 10%	15	.100"
120 pf	K121J15C0GFVAWA	CN15C121J	± 5%	15	.100"
120 pf	K121K15C0GFVAWA	CN15C121K	± 10%	15	.100"
150 pf	K151J15C0GFVAWA	CN15C151J	± 5%	15	.100"
150 pf	K151K15C0GFVAWA	CN15C151K	± 10%	15	.100"
180 pf	K181J15C0GFVAWA	CN15C181J	± 5%	15	.100"
180 pf	K181K15C0GFVAWA	CN15C181K	± 10%	15	.100"
220 pf	K221J15C0GFVAWA	CN15C221J	± 5%	15	.100"
220 pf	K221K15C0GFVAWA	CN15C221K	± 10%	15	.100"
270 pf	K271J15C0GFVAWA	CN15C271J	± 5%	15	.100"

***NOTE:** Part Numbers in stock listing reflect bulk packaging. Change packaging code in part number for tape and reel packaging.

SERIES K

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC and 200VDC, Multilayer Capacitors

STANDARD STOCK LISTING

2

Ceramic Capacitors

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	SIZE CODE	LEAD SPACE
50 Volt DCW C0G (NPO)					
270 pf	K271K15C0GFVAWA	CN15C271K	±10%	15	.100"
330 pf	K331J15C0GFVAWA	CN15C331J	±5%	15	.100"
330 pf	K331K15C0GFVAWA	CN15C331K	±10%	15	.100"
390 pf	K391J15C0GFVAWA	CN15C391J	±5%	15	.100"
390 pf	K391K15C0GFVAWA	CN15C391K	±10%	15	.100"
470 pf	K471J15C0GFVAWA	CN15C471J	±5%	15	.100"
470 pf	K471K15C0GFVAWA	CN15C471K	±10%	15	.100"
560 pf	K561J20C0GFVBWA	–	±5%	20	.100"
560 pf	K561K20C0GFVBWA	–	±10%	20	.100"
680 pf	K681J20C0GFVBWA	CN20C681J	±5%	20	.100"
680 pf	K681K20C0GFVBWA	CN20C681K	±10%	20	.100"
820 pf	K821J20C0GFVBWA	CN20C821J	±5%	20	.100"
.001 μf	K102J20C0GFVBWA	CN20C102J	±5%	20	.100"
.001 μf	K102K20C0GFVBWA	CN20C102K	±10%	20	.100"
.0012 μf	K122K20C0GFVBWA	CN20C122K	±10%	20	.100"
.0015 μf	K152J20C0GFVBWA	CN20C152J	±5%	20	.100"
.0015 μf	K152K20C0GFVBWA	CN20C152K	±10%	20	.100"
.0018 μf	K182J20C0GFVBWA	CN20C182J	±5%	20	.100"
.0018 μf	K182K20C0GFVBWA	CN20C182K	±10%	20	.100"
.0022 μf	K222J20C0GFVBWA	CN20C222J	±5%	20	.100"
.0022 μf	K222K20C0GFVBWA	CN20C222K	±10%	20	.100"
.0027 μf	K272K20C0GFVBWA	CN20C272K	±10%	20	.100"
.0033 μf	K332J20C0GFVBWA	CN20C332J	±5%	20	.100"
.0033 μf	K332K20C0GFVBWA	CN20C332K	±10%	20	.100"
.0039 μf	K392J30C0GFVCWA	CN30C392J	±5%	30	.200"
.0047 μf	K472J30C0GFVCWA	CN30C472J	±5%	30	.200"
.0047 μf	K472K30C0GFVCWA	CN30C472K	±10%	30	.200"
.0056 μf	K562K30C0GFVCWA	CN30C562K	±10%	30	.200"
.0068 μf	K682J30C0GFVCWA	CN30C682J	±5%	30	.200"
.0068 μf	K682K30C0GFVCWA	CN30C682K	±10%	30	.200"
.0082 μf	K822K30C0GFVCWA	CN30C822K	±10%	30	.200"
.01 μf	K103J30C0GFVCWA	CN30C103J	±5%	30	.200"
.01 μf	K103K30C0GFVCWA	CN30C103K	±10%	30	.200"
.015 μf	K153J40C0GFVCWC	CN40C153J	±5%	40	.200"
.022 μf	K223J40C0GFVCWE	CN40C223J	±5%	40	.200"
100 Volt DCW C0G (NPO)					
10 pf	K100J15C0GHVAWA	CN15A100J	±5%	15	.100"
10 pf	K100K15C0GHVAWA	CN15A100K	±10%	15	.100"
12 pf	K120J15C0GHVAWA	CN15A120J	±5%	15	.100"
12 pf	K120K15C0GHVAWA	CN15A120K	±10%	15	.100"
15 pf	K150J15C0GHVAWA	CN15A150J	±5%	15	.100"
15 pf	K150K15C0GHVAWA	CN15A150K	±10%	15	.100"
18 pf	K180J15C0GHVAWA	CN15A180J	±5%	15	.100"
18 pf	K180K15C0GHVAWA	CN15A180K	±10%	15	.100"
22 pf	K220J15C0GHVAWA	CN15A220J	±5%	15	.100"
22 pf	K220K15C0GHVAWA	CN15A220K	±10%	15	.100"

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC and 200VDC, Multilayer Capacitors

STANDARD STOCK LISTING

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	SIZE CODE	LEAD SPACE
100 Volt DCW C0G (NPO)					
27 pf	K270J15C0GHVAWA	CN15A270J	±5%	15	.100"
27 pf	K270K15C0GHVAWA	CN15A270K	±10%	15	.100"
33 pf	K330J15C0GHVAWA	CN15A330J	±5%	15	.100"
33 pf	K330K15C0GHVAWA	CN15A330K	±10%	15	.100"
39 pf	K390J15C0GHVAWA	CN15A390J	±5%	15	.100"
39 pf	K390K15C0GHVAWA	CN15A390K	±10%	15	.100"
47 pf	K470J15C0GHVAWA	CN15A470J	±5%	15	.100"
47 pf	K470K15C0GHVAWA	CN15A470K	±10%	15	.100"
56 pf	K560J15C0GHVAWA	CN15A560J	±5%	15	.100"
56 pf	K560K15C0GHVAWA	CN15A560K	±10%	15	.100"
68 pf	K680J15C0GHVAWA	CN15A680J	±5%	15	.100"
68 pf	K680K15C0GHVAWA	CN15A680K	±10%	15	.100"
82 pf	K820J15C0GHVAWA	CN15A820J	±5%	15	.100"
82 pf	K820K15C0GHVAWA	CN15A820K	±10%	15	.100"
100 pf	K101J15C0GHVAWA	CN15A101J	±5%	15	.100"
100 pf	K101K15C0GHVAWA	CN15A101K	±10%	15	.100"
120 pf	K121J15C0GHVAWA	CN15A121J	±5%	15	.100"
120 pf	K121K15C0GHVAWA	CN15A121K	±10%	15	.100"
150 pf	K151J15C0GHVAWA	CN15A151J	±5%	15	.100"
150 pf	K151K15C0GHVAWA	CN15A151K	±10%	15	.100"
180 pf	K181J15C0GHVAWA	CN15A181J	±5%	15	.100"
180 pf	K181K15C0GHVAWA	CN15A181K	±10%	15	.100"
220 pf	K221J15C0GHVAWA	CN15A221J	±5%	15	.100"
220 pf	K221K15C0GHVAWA	CN15A221K	±10%	15	.100"
270 pf	K271J15C0GHVAWA	CN20A271J	±5%	15	.100"
270 pf	K271K15C0GHVAWA	CN20A271K	±10%	15	.100"
330 pf	K331J15C0GHVAWA	CN20A331J	±5%	15	.100"
330 pf	K331K15C0GHVAWA	CN20A331K	±10%	15	.100"
390 pf	K391J15C0GHVAWA	CN20A391J	±5%	15	.100"
390 pf	K391K15C0GHVAWA	CN20A391K	±10%	15	.100"
470 pf	K471J20C0GHVBWA	CN20A471J	±5%	20	.100"
470 pf	K471K20C0GHVBWA	CN20A471K	±10%	20	.100"
560 pf	K561J20C0GHVBWA	CN20A561J	±5%	20	.100"
560 pf	K561K20C0GHVBWA	CN20A561K	±10%	20	.100"
680 pf	K681J20C0GHVBWA	CN20A681J	±5%	20	.100"
680 pf	K681K20C0GHVBWA	CN20A681K	±10%	20	.100"
820 pf	K821J20C0GHVBWA	CN20A821J	±5%	20	.100"
820 pf	K821K20C0GHVBWA	CN20A821K	±10%	20	.100"
.001 μf	K102J20C0GHVBWA	CN20A102J	±5%	20	.100"
.001 μf	K102K20C0GHVBWA	CN20A102K	±10%	20	.100"
.0012 μf	K122J20C0GHVBWA	CN20A122J	±5%	20	.100"
.0015 μf	K152J20C0GHVBWA	CN20A152J	±5%	20	.100"
.0015 μf	K152K20C0GHVBWA	CN20A152K	±10%	20	.100"
.0018 μf	K182J30C0GHVCWA	CN30A182J	±5%	30	.200"
.0018 μf	K282K30C0GHVCWA	CN30A182K	±10%	30	.200"
.0022 μf	K222J30C0GHVCWA	CN30A222J	±5%	30	.200"
.0022 μf	K222K30C0GHVCWA	CN30A222K	±10%	30	.200"

SERIES K

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC and 200VDC, Multilayer Capacitors

STANDARD STOCK LISTING

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.		SIZE CODE	LEAD SPACE
100 Volt DCW C0G (NPO)						
.0027 μf	K272J30C0GHVCWA	CN30A272J	±5%		30	.200″
.0027 μf	K272K30C0GHVCWA	CN30A272K	±10%		30	.200″
.0033 μf	K332J30C0GHVCWA	CN30A332J	±5%		30	.200″
.0033 μf	K332K30C0GHVCWA	CN30A332K	±10%		30	.200″
.0039 μf	K392J30C0GHVCWA	CN30A392J	±5%		30	.200″
.0047 μf	K472J30C0GHVCWA	CN30A472J	±5%		30	.200″
.0047 μf	K472K30C0GHVCWA	CN30A472K	±10%		30	.200″
.0068 μf	K682J30C0GHVCWA	CN30A682J	±5%		30	.200″
.01 μf	K103J40C0GHVCWA	CN40A103J	±5%		40	.200″
.01 μf	K103K40C0GHVCWA	CN40A103K	±10%		40	.200″
50 Volt DCW X7R						
150 pf	K151K15X7RFVAWA	CW15C151K	±10%		15	.100″
180 pf	K181K15X7RFVAWA	CW15C181K	±10%		15	.100″
180 pf	K181M15X7RFVAWA	CW15C181M	±20%		15	.100″
220 pf	K221K15X7RFVAWA	CW15C221K	±10%		15	.100″
270 pf	K271K15X7RFVAWA	CW15C271K	±10%		15	.100″
270 pf	K271M15X7RFVAWA	CW15C271M	±20%		15	.100″
330 pf	K331K15X7RFVAWA	CW15C331K	±10%		15	.100″
330 pf	K331M15X7RFVAWA	CW15C331M	±20%		15	.100″
390 pf	K391K15X7RFVAWA	CW15C391K	±10%		15	.100″
390 pf	K391M15X7RFVAWA	CW15C391M	±20%		15	.100″
470 pf	K471K15X7RFVAWA	CW15C471K	±10%		15	.100″
470 pf	K471M15X7RFVAWA	CW15C471M	±20%		15	.100″
560 pf	K561K15X7RFVAWA	CW15C561K	±10%		15	.100″
680 pf	K681K15X7RFVAWA	CW15C681K	±10%		15	.100″
680 pf	K681M15X7RFVAWA	CW15C681M	±20%		15	.100″
820 pf	K821K15X7RFVAWA	CW15C821K	±10%		15	.100″
820 pf	K821M15X7RFVAWA	CW15C321M	±20%		15	.100″
.001 μf	K102K15X7RFVAWA	CW15C102K	±10%		15	.100″
.001 μf	K102K15X7RFTTWA	–	±10%	T&R	15	.200″
.001 μf	K102M15X7RFVAWA	CW15C102M	±20%		15	.100″
.001 μf	K102M15X7RFTTWA	–	±20%	T&R	15	.200″
.0012 μf	K122K15X7RFVAWA	CW15C122K	±10%		15	.100″
.0015 μf	K152K15X7RFVAWA	CW15C152K	±10%		15	.100″
.0018 μf	K182K15X7RFVAWA	CW15C182K	±10%		15	.100″
.0022 μf	K222K15X7RFVAWA	CW15C222K	±10%		15	.100″
.0022 μf	K222M15X7RFVAWA	CW15C222M	±20%		15	.100″
.0027 μf	K272K15X7RFVAWA	CW15C272K	±10%		15	.100″
.0027 μf	K272M15X7RFVAWA	CW15C272M	±20%		15	.100″
.0033 μf	K332K15X7RFVAWA	CW15C332K	±10%		15	.100″
.0033 μf	K332M15X7RFVAWA	CW15C332M	±20%		15	.100″
.0039 μf	K392K15X7RFVAWA	CW15C392K	±10%		15	.100″
.0047 μf	K472K15X7RFVAWA	CW15C472K	±10%		15	.100″
.0047 μf	K472M15X7RFVAWA	CW15C472M	±20%		15	.100″
.0056 μf	K562K15X7RFVAWA	CW15C562K	±10%		15	.100″
.0056 μf	K562M15X7RFVAWA	CW15C562M	±20%		15	.100″
.0068 μf	K682K15X7RFVAWA	CW15C682K	±10%		15	.100″
.0068 μf	K682M15X7RFVAWA	CW15C682M	±20%		15	.100″

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC and 200VDC, Multilayer Capacitors

STANDARD STOCK LISTING

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.		SIZE CODE	LEAD SPACE
50 Volt DCW X7R						
.0082 μf	K822K15X7RFVAWA	CW15C822K	±10%		15	.100″
.0082 μf	K822M15X7RFVAWA	CW15C822M	±20%		15	.100″
.01 μf	K103K15X7RFVAWA	CW15C103K	±10%		15	.100″
.01 μf	K103K15X7RFVCWA	CW20C103K244	±10%		15	.200″
.01 μf	K103K15X7RFTTWA	–	±10%	T&R	15	.200″
.01 μf	K103M15X7RFVAWA	CW15C103M	±20%		15	.100″
.01 μf	K103M15X7RFVCWA	CW20C103M244	±20%		15	.200″
.01 μf	K103M15X7RFTTWA	–	±10%	T&R	15	.200″
.015 μf	K153K15X7RFVAWC	CW15C153K	±10%		15	.100″
.015 μf	K153M15X7RFVAWC	CW15C153M	±20%		15	.100″
.018 μf	K183K15X7RFVBWD	CW20C183K	±10%		15	.100″
.018 μf	K183M15X7RFVBWD	CW20C183M	±20%		15	.100″
.022 μf	K223K15X7RFVBWE	CW20C223K	±10%		15	.100″
.022 μf	K223K15X7RFVCWE	CW20C223K244	±10%		15	.200″
.022 μf	K223K15X7RFTTWE	–	±10%	T&R	15	.200″
.022 μf	K223M15X7RFVBWE	CW20C223M	±20%		15	.100″
.022 μf	K223M15X7RFVCWE	CW20C223M244	±20%		15	.200″
.022 μf	K823M15X7RFTTWE	–	±10%	T&R	15	.200″
.027 μf	K273K15X7RFVBWF	CW20C273K	±10%		15	.100″
.033 μf	K333K20X7RFVBWG	CW20C333K	±10%		20	.100″
.033 μf	K333M20X7RFVBWG	CW20C333M	±20%		20	.100″
.039 μf	K393K20X7RFVBWH	CW20C393K	±10%		20	.100″
.047 μf	K473K20X7RFVBWJ	CW20C473K	±10%		20	.100″
.047 μf	K473K20X7RFVCWJ	CW20C473K244	±10%		20	.200″
.047 μf	K473K20X7RFTTWJ	–	±10%	T&R	20	.200″
.047 μf	K473M20X7RFVBWJ	CW20C473M	±20%		20	.100″
.047 μf	K473M20X7RFVCWJ	CW20C473M244	±20%		20	.200″
.047 μf	K473M20X7RFTTWJ	–	±20%	T&R	20	.200″
.056 μf	K563K20X7RFVBWK	CW20C563K	±10%		20	.100″
.056 μf	K563M20X7RFVBWK	CW20C563M	±20%		20	.100″
.068 μf	K683K20X7RFVBWL	CW20C683K	±10%		20	.100″
.068 μf	K683M20X7RFVBWL	CW20C683M	±20%		20	.100″
.082 μf	K823K20X7RFVBWM	CW20C823K	±10%		20	.100″
.10 μf	K104K20X7RFVBWN	CW20C104K	±10%		20	.100″
.10 μf	K104K20X7RFVCWN	CW20C104K244	±10%		20	.200″
.10 μf	K104K20X7RFTTWN	–	±10%	T&R	20	.200″
.10 μf	K104K20X7RFVCWN	CW30C104K	±10%		20	.200″
.10 μf	K104M20X7RFVBWN	CW20C104M	±20%		20	.100″
.10 μf	K104M20X7RFVCWN	CW20C104M244	±20%		20	.200″
.10 μf	K104M20X7RFTTWN	–	±20%	T&R	20	.200″
.10 μf	K104M20X7RFVCWN	CW30C104M	±20%		20	.200″
.12 μf	K124K20X7RFVCWP	CW30C124K	±10%		20	.200″
.12 μf	K124M20X7RFVCWP	CW30C124M	±20%		20	.200″
.15 μf	K154K30X7RFVCWR	CW30C154K	±10%		30	.200″
.15 μf	K154M30X7RFVCWR	CW30C154M	±20%		30	.200″
.18 μf	K184K30X7RFVCWS	CW30C184K	±10%		30	.200″

SERIES K

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC and 200VDC, Multilayer Capacitors

STANDARD STOCK LISTING

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	SIZE CODE	LEAD SPACE
50 Volt DCW X7R					
.18 µf	K184M30X7RFVCWS	CW30C184M	±20%	30	.200″
.22 µf	K224K30X7RFVCWT	CW30C224K	±10%	30	.200″
.22 µf	K224M30X7RFVCWT	CW30C224M	±20%	30	.200″
.27 µf	K274K30X7RFVCWU	CW30C274K	±10%	30	.200″
.27 µf	K274M30X7RFVCWU	CW30C274M	±20%	30	.200″
.33 µf	K334K30X7RFVCWW	CW30C334K	±10%	30	.200″
.33 µf	K334M30X7RFVCWW	CW30C334M	±20%	30	.200″
.39 µf	K394K30X7RFVCWX	CW40C394K	±10%	30	.200″
.47 µf	K474K30X7RFVCWY	CW40C474K	±10%	30	.200″
.47 µf	K474M30X7RFVCWY	CW40C474M	±20%	30	.200″
.56 µf	K564M40X7RFVCXA	CW40C564M	±20%	40	.200″
.68 µf	K684K40X7RFVCXB	CW40C684K	±10%	40	.200″
.82 µf	K824M40X7RFVHXC	CW50C824M	±20%	40	.400″
1.0 µf	K105K40X7RFVHXD	CW50C105K	±10%	40	.400″
1.0 µf	K105M40X7RFVHXD	CW50C105M	±20%	40	.400″
100 Volt DCW X7R					
150 pf	K151K15X7RHVAWA	CW15A151K	±10%	15	.100″
150 pf	K151M15X7RHVAWA	CW15A151M	±20%	15	.100″
180 pf	K181K15X7RHVAWA	CW15A181K	±10%	15	.100″
220 pf	K221K15X7RHVAWA	CW15A221K	±10%	15	.100″
220 pf	K221M15X7RHVAWA	CW15A221M	±20%	15	.100″
270 pf	K271K15X7RHVAWA	CW15A271K	±10%	15	.100″
330 pf	K331K15X7RHVAWA	CW15A331K	±10%	15	.100″
330 pf	K331M15X7RHVAWA	CW15A331M	±20%	15	.100″
390 pf	K391K15X7RHVAWA	CW15A391K	±10%	15	.100″
390 pf	K391M15X7RHVAWA	CW15A391M	±20%	15	.100″
470 pf	K471K15X7RHVAWA	CW15A471K	±10%	15	.100″
470 pf	K471M15X7RHVAWA	CW15A471M	±20%	15	.100″
560 pf	K561K15X7RHVAWA	CW15A561K	±10%	15	.100″
560 pf	K561M15X7RHVAWA	CW15A561M	±20%	15	.100″
680 pf	K681K15X7RHVAWA	CW15A681K	±10%	15	.100″
820 pf	K821K15X7RHVAWA	CW15A821K	±10%	15	.100″
.001 µf	K102K15X7RHVAWA	CW15A102K	±10%	15	.100″
.001 µf	K102M15X7RHVAWA	CW15A102M	±20%	15	.100″
.0012 µf	K122K15X7RHVAWA	CW15A122K	±10%	15	.100″
.0012 µf	K122M15X7RHVAWA	CW15A122M	±20%	15	.100″
.0015 µf	K152K15X7RHVAWA	CW15A152K	±10%	15	.100″
.0018 µf	K182K15X7RHVAWA	CW15A182K	±10%	15	.100″
.0022 µf	K222K15X7RHVAWA	CW15A222K	±10%	15	.100″
.0022 µf	K222M15X7RHVAWA	CW15A222M	±20%	15	.100″
.0027 µf	K272K15X7RHVAWA	CW15A272K	±10%	15	.100″
.0033 µf	K332K15X7RHVAWA	CW15A332K	±10%	15	.100″
.0033 µf	K332M15X7RHVAWA	CW15A332M	±20%	15	.100″
.0039 µf	K392K15X7RHVAWA	CW15A392K	±10%	15	.100″
.0047 µf	K472K15X7RHVAWA	CW15A472K	±10%	15	.100″
.0047 µf	K472M15X7RHVAWA	CW15A472M	±20%	15	.100″
.0056 µf	K562K15X7RHVAWA	CW15A562K	±10%	15	.100″

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC and 200VDC, Multilayer Capacitors

STANDARD STOCK LISTING

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.		SIZE CODE	LEAD SPACE
100 Volt DCW X7R						
.0068 µf	K682K15X7RHVBWA	CW20A682K	±10%		15	.100"
.0068 µf	K682M15X7RHVBWA	CW20A682M	±20%		15	.100"
.0082 µf	K822K15X7RHVBWA	CW20A822K	±10%		15	.100"
.01 µf	K103K15X7RHVBWA	CW20A103K	±10%		15	.100"
.01 µf	K103K15X7RHVCWA	CW20A103K244	±10%		15	.200"
.01 µf	K103M15X7RHVBWA	CW20A103M	±20%		15	.100"
.01 µf	K103M15X7RHVCWA	CW20A103M244	±20%		15	.200"
.012 µf	K123K15X7RHVBWB	CW20A123K	±10%		15	.100"
.015 µf	K153K20X7RHVBWC	CW20A153K	±10%		20	.100"
.015 µf	K153M20X7RHVBWC	CW20A153M	±20%		20	.100"
.018 µf	K183K20X7RHVBWD	CW20A183K	±10%		20	.100"
.022 µf	K223K20X7RHVBWE	CW20A223K	±10%		20	.100"
.022 µf	K223K20X7RHVCWE	CW20A223K244	±10%		20	.200"
.022 µf	K223M20X7RHVBWE	CW20A223M	±20%		20	.100"
.022 µf	K223M20X7RHVCWE	CW20A223M244	±20%		20	.200"
.027 µf	K273K20X7RHVBWF	CW20A273K	±10%		20	.100"
.027 µf	K273M20X7RHVBWF	CW20A273M	±20%		20	.100"
.033 µf	K333K20X7RHVCWG	CW30A333K	±10%		20	.200"
.033 µf	K333M20X7RHVCWG	CW30A333M	±20%		20	.200"
.039 µf	K393M20X7RHVCWH	CW30A393M	±20%		20	.200"
.047 µf	K473K20X7RHVCWJ	CW20A473K244	±10%		20	.200"
.047 µf	K473M20X7RHVCWJ	CW20A473M244	±20%		20	.200"
.056 µf	K563K20X7RHVCWK	CW30A563K	±10%		20	.200"
.068 µf	K683K20X7RHVCWL	CW30A683K	±10%		20	.200"
.068 µf	K683M20X7RHVCWL	CW30A683M	±20%		20	.200"
.082 µf	K823M20X7RHVCWM	CW30A823M	±20%		20	.200"
.10 µf	K104K20X7RHVCWN	CW30A104K	±10%		20	.200"
.10 µf	K104K20X7RHTTWN	—	±10%	T&R	20	.200"
.10 µf	K104M20X7RHVCWN	CW30A104M	±20%		20	.200"
.12 µf	K124K30X7RHVCWP	CW30A124K	±10%		30	.200"
.12 µf	K124M30X7RHVCWP	CW30A124M	±20%		30	.200"
.22 µf	K224K30X7RHVCWT	CW40A224K	±10%		30	.200"
.22 µf	K224M30X7RHVCWT	CW40A224M	±20%		30	.200"
.33 µf	K334K30X7RHVCWW	CW40A334K	±10%		30	.200"
.39 µf	K394K50X7RHVHWX	CW50A394K	±10%		50	.400"
.47 µf	K474K50X7RHVHWY	CW50A474K	±10%		50	.400"
.47 µf	K474M50X7RHVHWY	CW50A474M	±20%		50	.400"
.56 µf	K564K50X7RHVHXA	CW50A564K	±10%		50	.400"
.56 µf	K564M50X7RHVHXA	CW50A564M	±20%		50	.400"
50 Volt DCW Y5V						
270 pf	K271Z15Y5VFVAWA	CY15C271Z	+80-20%		15	.100"
330 pf	K331Z15Y5VFVAWA	CY15C331Z	+80-20%		15	.100"
390 pf	K391Z15Y5VFVAWA	CY15C391Z	+80-20%		15	.100"
680 pf	K681Z15Y5VFVAWA	CY15C681Z	+80-20%		15	.100"
.001 µf	K102M15Y5VFVAWA	CY15C102M	±20%		15	.100"
.0015 µf	K152Z15Y5VFVAWA	CY15C152Z	+80-20%		15	.100"
.0018 µf	K182Z15Y5VFVAWA	CY15C182Z	+80-20%		15	.100"

SERIES K

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC and 200VDC, Multilayer Capacitors

STANDARD STOCK LISTING

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	SIZE CODE	LEAD SPACE
50 Volt DCW Y5V					
.0022 μf	K222M15Y5VFVAWA	CY15C222M	±20%	15	.100"
.0027 μf	K272Z15Y5VFVAWA	CY15C272Z	+80-20%	15	.100"
.0033 μf	K332M15Y5VFVAWA	CY15C332M	±20%	15	.100"
.0039 μf	K392Z15Y5VFVAWA	CY15C392Z	+80-20%	15	.100"
.0047 μf	K472M15Y5VFVAWA	CY15C472M	±20%	15	.100"
.0056 μf	K562Z15Y5VFVAWA	CY15C562Z	+80-20%	15	.100"
.0068 μf	K682M15Y5VFVAWA	CY15C682M	±20%	15	.100"
.01 μf	K103M15Y5VFVAWA	CY15C103M	±20%	15	.100"
.01 μf	K103M15Y5VFVCWA	CY20C103M244	±20%	15	.200"
.01 μf	K103P15Y5VFVAWA	CY15C103P	GMV	15	.100"
.01 μf	K103Z15Y5VFVAWA	CY15C103Z	+80-20%	15	.100"
.01 μf	K103Z15Y5VFVCWA	CY20C103Z244	+80-20%	15	.200"
.015 μf	K153Z15Y5VFVAWC	CY15C153Z	+80-20%	15	.100"
.022 μf	K223M15Y5VFVAWE	CY15C223M	±20%	15	.100"
.022 μf	K223Z15Y5VFVAWE	CY15C223Z	+80-20%	15	.100"
.022 μf	K223Z15Y5VFVCWE	CY20C223Z244	+80-20%	15	.200"
.047 μf	K473M20Y5VFVCWJ	CY20C473M244	±20%	20	.200"
.056 μf	K563Z20Y5VFVBWK	CY15C563Z	+80-20%	20	.100"
.10 μf	K104M20Y5VFVBWN	CY20C104M	±20%	20	.100"
.10 μf	K104M20Y5VFVCWN	CY20C104M244	±20%	20	.200"
.10 μf	K104P20Y5VFVBWN	CY20C104P	GMV	20	.100"
.10 μf	K104Z20Y5VFVBWN	CY20C104Z	+80-20%	20	.100"
.10 μf	K104Z20Y5VFVCWN	CY20C104Z244	+80-20%	20	.200"
.12 μf	K124Z20Y5VFVBWP	CY20C124Z	+80-20%	20	.100"
.15 μf	K154M20Y5VFVBWR	CY20C154M	±20%	20	.100"
.22 μf	K224M20Y5VFVBWT	CY20C224M	±20%	20	.100"
.22 μf	K224Z20Y5VFVCWT	CY20C224Z244	+80-20%	20	.200"
.27 μf	K274Z30Y5VFVCWU	–	+80-20%	30	.200"
.47 μf	K474Z30Y5VFVCWY	–	+80-20%	30	.200"
.68 μf	K684M30Y5VFVCXB	CY30C684M	±20%	30	.200"
1.0 μf	K105M30Y5VFVCXD	CY30C105M	±20%	30	.200"
1.0 μf	K105P30Y5VFVCXD	CY30C105P	GMV	30	.200"
1.0 μf	K105Z30Y5VFVCXD	CY30C105Z	+80-20%	30	.200"
100 Volt DCW Y5V					
330 pf	K331Z15Y5VHVAWA	CY15A331Z	+80-20%	15	.100"
390 pf	K391Z15Y5VHVAWA	CY15A391Z	+80-20%	15	.100"
470 pf	K471Z15Y5VHVAWA	CY15A471Z	+80-20%	15	.100"
560 pf	K561Z15Y5VHVAWA	CY15A561Z	+80-20%	15	.100"
680 pf	K681Z15Y5VHVAWA	CY15A681Z	+80-20%	15	.100"
.001 μf	K102Z15Y5VHVAWA	CY15A102Z	+80-20%	15	.100"
.0012 μf	K122Z15Y5VHVAWA	CY15C122Z	+80-20%	15	.100"
.0015 μf	K152Z15Y5VHVAWA	CY15A152Z	+80-20%	15	.100"
.0018 μf	K182Z15Y5VHVAWA	CY15A182Z	+80-20%	15	.100"
.0039 μf	K392Z15Y5VHVAWA	CY15A392Z	+80-20%	15	.100"
.0047 μf	K472Z15Y5VHVAWA	CY15A472Z	+80-20%	15	.100"
.0056 μf	K562Z15Y5VHVAWA	CY15A562Z	+80-20%	15	.100"
.0068 μf	K682Z15Y5VHVAWA	CY15A682Z	+80-20%	15	.100"

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC and 200VDC, Multilayer Capacitors

STANDARD STOCK LISTING

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.		SIZE CODE	LEAD SPACE
100 Volt DCW Y5V						
.01 µf	K103M15Y5VHVAWA	CY15A103M	±20%		15	.100"
.01 µf	K103M15Y5VHVCWA	CY20A103M244	±20%		15	.200"
.01 µf	K103P15Y5VHVAWA	CY15A103P	GMV		15	.100"
.01 µf	K103Z15Y5VHVAWA	CY15A103Z	+80-20%		15	.100"
.01 µf	K103Z15Y5VHVCWA	CY20A103Z244	+80-20%		15	.200"
.012 µf	K123Z15Y5VHVAWB	CY15A123Z	+80-20%		15	.100"
.015 µf	K153Z15Y5VHVAWC	CY15A153Z	+80-20%		15	.100"
.022 µf	K223M15Y5VHVCWE	CY20A223M244	±20%		15	.200"
.022 µf	K223Z15Y5VHVCWE	CY20A223Z244	+80-20%		15	.200"
.027 µf	K273Z20Y5VHVBWF	CY15A273Z	+80-20%		20	.100"
.047 µf	K473M20Y5VHVBWJ	CY20A473M	±20%		20	.100"
.10 µf	K104M20Y5VHVBWN	CY20A104M	±20%		20	.100"
.10 µf	K104M20Y5VHVCWN	CY20A104M244	±20%		20	.200"
.10 µf	K104P20Y5VHVBWN	CY20A104P	GMV		20	.100"
.10 µf	K104Z20Y5VHVBWN	CY20A104Z	+80-20%		20	.100"
.10 µf	K104Z20Y5VHVCWN	CY20A104Z244	+80-20%		20	.200"
.15 µf	K154Z20Y5VHVBWR	CY20A154Z	+80-20%		20	.100"
.22 µf	K224Z30Y5VHVCWT	—	+80-20%		30	.200"
.27 µf	K274Z30Y5VHVCWU	CY30A274Z	+80-20%		30	.200"
.33 µf	K334M30Y5VHVCWW	CY30A334M	±20%		30	.200"
.47 µf	K474M30Y5VHVCWW	CY30A474M	±20%		30	.200"
.47 µf	K474Z30Y5VHVCWW	CY30A474Z	+80-20%		30	.200"
50 Volt DCW Z5U						
.001 µf	K102M15Z5UFVAWA	CZ15C102M	±20%		15	.100"
.0015 µf	K152M15Z5UFVAWA	CZ15C152M	±20%		15	.100"
.0018 µf	K182Z15Z5UFVAWA	CZ15C1822	+80-20%		15	.100"
.0022 µf	K222M15Z5UFVAWA	CZ15C222M	±20%		15	.100"
.0033 µf	K332Z15Z5UFVAWA	CZ15C332Z	+80-20%		15	.100"
.0039 µf	K392M15Z5UFVAWA	CZ15C392M	±20%		15	.100"
.0047 µf	K472Z15Z5UFVAWA	CZ15C472Z	+80-20%		15	.100"
.0068 µf	K682M15Z5UFVAWA	CZ15C682M	±20%		15	.100"
.0068 µf	K682Z15Z5UFVAWA	CZ15C682Z	+80-20%		15	.100"
.0082 µf	K822M15Z5UFVAWA	CZ15C822M	±20%		15	.100"
.01 µf	K103M15Z5UFVAWA	CZ15C103M	±20%		15	.100"
.01 µf	K103M15Z5UFVCWA	CZ20C103M244	±20%		15	.200"
.01 µf	K103M15Z5UFTTWA	—	±20%	T&R	15	.200"
.01 µf	K103Z15Z5UFVAWA	CZ15C103Z	+80-20%		15	.100"
.01 µf	K103Z15Z5UFVCWA	CZ20C103Z244	+80-20%		15	.200"
.01 µf	K103Z15Z5UFTTWA	—	+80-20%	T&R	15	.200"
.012 µf	K123M15Z5UFVAWB	CZ15C123M	±20%		15	.100"
.012 µf	K123Z15Z5UFVAWB	CZ15C123Z	+80-20%		15	.100"
.018 µf	K183M15Z5UFVAWD	CZ15C183M	±20%		15	.100"
.022 µf	K223M15Z5UFVAWE	CZ15C223M	±20%		15	.100"
.022 µf	K223M15Z5UFVCWE	CZ20C223M244	±20%		15	.200"
.022 µf	K223Z15Z5UFVAWE	CZ15C223Z	+80-20%		15	.100"
.022 µf	K223Z15Z5UFVCWE	CZ20C223Z244	+80-20%		15	.200"
.027 µf	K273M15Z5UFVAWF	CZ15C273M	±20%		15	.100"
.033 µf	K333M15Z5UFVAWG	CZ15C333M	±20%		15	.100"

SERIES K

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC and 200VDC, Multilayer Capacitors

STANDARD STOCK LISTING

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.		SIZE CODE	LEAD SPACE
50 Volt DCW Z5U						
.033 μf	K333Z15Z5UFVAWG	CZ15C333Z	+80-20%		15	.100"
.047 μf	K473M20Z5UFVBWJ	CZ20C473M	±20%		20	.100"
.047 μf	K473M20Z5UFVCWJ	CZ20C473M244	±20%		20	.200"
.047 μf	K473Z20Z5UFVBWJ	CZ20C473Z	+80-20%		20	.100"
.047 μf	K473Z20Z5UFVCWJ	CZ20C473Z244	+80-20%		20	.200"
.068 μf	K683M20Z5UFVBWL	CZ20C683M	±20%		20	.100"
.068 μf	K683Z20Z5UFVBWL	CZ20C683Z	+80-20%		20	.100"
.10 μf	K104M20Z5UFVBWN	CZ20C104M	±20%		20	.100"
.10 μf	K104M20Z5UFVCWN	CZ20C104M244	±20%		20	.200"
.10 μf	K104M20Z5UFTTWN	–	±20%	T&R	20	.200"
.10 μf	K104Z20Z5UFVBWN	CZ20C104Z	+80-20%		20	.100"
.10 μf	K104Z20Z5UFVCWN	CZ20C104Z244	+80-20%		20	.200"
.10 μf	K104Z20Z5UFTTWN	–	+80-20%	T&R	20	.200"
.12 μf	K124M20Z5UFVBWP	CZ20C124M	±20%		20	.100"
.15 μf	K154M20Z5UFVBWR	CZ20C154M	±20%		20	.100"
.15 μf	K154Z20Z5UFVBWR	CZ20C154Z	+80-20%		20	.100"
.18 μf	K184M20Z5UFVBWS	CZ20C184M	±20%		20	.100"
.22 μf	K224M20Z5UFVBWT	CZ20C224M	±20%		20	.100"
.22 μf	K224M20Z5UFVCWT	CZ20C224M244	±20%		20	.200"
.22 μf	K224M20Z5UFTTWT	–	±20%	T&R	20	.200"
.22 μf	K224Z20Z5UFVBWT	CZ20C224Z	+80-20%		20	.100"
.22 μf	K224Z20Z5UFVCWT	CZ20C224Z244	+80-20%		20	.200"
.33 μf	K334M20Z5UFVCWW	CZ30C334M	±20%		20	.200"
.47 μf	K474M30Z5UFVCWY	CZ30C474M	±20%		30	.200"
.47 μf	K474M30Z5UFTTWY	–	±20%	T&R	30	.200"
.47 μf	K474Z30Z5UFVCWY	CZ30C474Z	+80-20%		30	.200"
.68 μf	K684M30Z5UFVCXB	CZ30C684M	±20%		30	.200"
.82 μf	K824M30Z5UFVCXC	CZ30C824M	±20%		30	.200"
1.0 μf	K105M30Z5UFVCXD	CZ30C105M	±20%		30	200"
1.0 μf	K105M30Z5UFTTXD	–	±20%	T&R	30	.200"
1.0 μf	K105Z30Z5UFVCXD	CZ30C105Z	+80-20%		30	.200"
1.5 μf	K155M40Z5UFVCXE	CZ40C155M	±20%		40	.200"
1.8 μf	K185M40Z5UFVCXF	CZ40C185M	±20%		40	.200"
2.2 μf	K225M40Z5UFVCXF	CZ40C225M	±20%		40	.200"
2.2 μf	K225Z40Z5UFVCXF	CZ40C225Z	+80-20%		40	.200"
3.3 μf	K335M50Z5UFVHXH	CZ50C335M	±20%		50	.400"
4.7 μf	K475M50Z5UFVHXJ	CZ50C475M	±20%		50	.400"
4.7 μf	K475Z50Z5UFVHXJ	CZ50C475Z	+80-20%		50	.400"
100 Volt DCW Z5U						
.001 μf	K102M15Z5UHVAWA	CZ15A102M	±20%		15	.100"
.001 μf	K102Z15Z5UHVAWA	CZ15A102Z	+80-20%		15	.100"
.0022 μf	K222M15Z5UHVAWA	CZ15A222M	±20%		15	.100"
.0033 μf	K332Z15Z5UHVAWA	CZ15A332M	+80-20%		15	.100"
.0039 μf	K392M15Z5UHVAWA	CZ15A392M	±20%		15	.100"
.0047 μf	K472M15Z5UHVAWA	CZ15A472M	±20%		15	.100"
.0047 μf	K472Z15Z5UHVAWA	CZ15A472Z	+80-20%		15	.100"
.0082 μf	K822M15Z5UHVAWA	CZ15A822M	±20%		15	.100"

Mono-Kap® C0G, X7R, Y5V and Z5U, 50VDC, 100VDC and 200VDC, Multilayer Capacitors

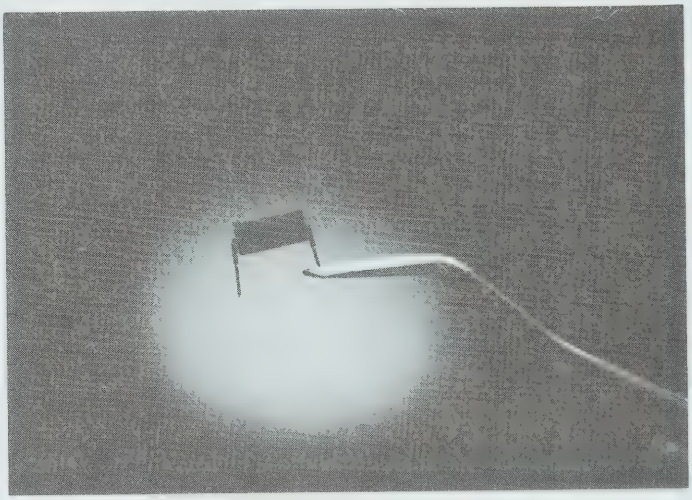
STANDARD STOCK LISTING

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	SIZE CODE	LEAD SPACE
.01 µf	K103M15Z5UHVAWA	CZ15A103M	±20%	15	.100″
.01 µf	K103M15Z5UHVCWA	CZ20A103M244	±20%	15	.200″
.01 µf	K103Z15Z5UHVAWA	CZ15A103Z	+80-20%	15	.100″
.01 µf	K103Z15Z5UHVCWA	CZ20A103Z244	+80-20%	15	.200″
.012 µf	K123M15Z5UHVAWB	CZ15A123M	±20%	15	.100″
.022 µf	K223M20Z5UHVBWE	CZ20A223M	±20%	20	.200″
.022 µf	K223M20Z5UHVCWE	CZ20A223ZM244	±20%	20	.200″
.022 µf	K223Z20Z5UHVCWE	CZ20A223Z244	+80-20%	20	.200″
.033 µf	K333M20Z5UHVBWG	CZ20A333M	±20%	20	.100″
.039 µf	K393M20Z5UHVBWH	CZ20A393M	±20%	20	.100″
.047 µf	K473M20Z5UHVBWJ	CZ20A473M	±20%	20	.100″
.047 µf	K473M20Z5UHVCWJ	CZ20A473M244	±20%	20	.200″
.068 µf	K683M20Z5UHVBWL	CZ20A683M	±20%	20	.100″
.10 µf	K104M20Z5UHVBWN	CZ20A104M	±20%	20	.100″
.10 µf	K104M20Z5UHVCWN	CZ20A104M244	±20%	20	.200″
.10 µf	K104Z20Z5UHVBWN	CZ20A104Z	+80-20%	20	.100″
.10 µf	K104Z20Z5UHVCWN	CZ20A104Z244	+80-20%	20	.200″
.12 µf	K124M20Z5UHVBWP	CZ20A124M	±20%	20	.100″
.15 µf	K154M20Z5UHVCWR	CZ20A154M	±20%	30	.200″
.22 µf	K224M30Z5UHVCWT	CZ30A224M	±20%	30	.200″
.33 µf	K334M30Z5UHVCWW	CZ30A334M	±20%	30	.200″
.47 µf	K474M30Z5UHVCWY	CZ30A474M	±20%	30	.200″
.47 µf	K474Z30Z5UHVCWY	CZ30A474Z	+80-20%	30	.200″
1.0 µf	K105M40Z5UHVCXD	CZ40A105M	±20%	40	.200″
2.2 µf	K225M50Z5UHVHXF	CZ50A225M	±20%	50	.400″

Consult factory representative for other values.

SERIES P

Mono-Pak® Dual In-Line Ceramic Multilayer Capacitors



DESCRIPTION:

Two pin, dual In-Line capacitors feature a .165 maximum inserted height, compatible with IC's and other DIP's. The units are packed for automatic insertion.

ELECTRICAL PARAMETERS:

CAPACITANCE:

Measured @ 1MHz @ 1.0±0.2VRMS @ 25°C for C0G types with C≤1000pF.

Measured @ 1KHz @ 1.0±0.2VRMS @ 25°C for C0G types with C>1000pF.

Measured @ 1Khz @ 1.0VRMS ± .2VRMS @ 25°C for X7R types.

Measured @ 1Khz @ .5VRMS ± .1VRMS @ 25°C for Z5U types.

DISSIPATION FACTOR:

.1% Maximum for C0G types,
2.5% Maximum for X7R types and
4.0% Maximum for Z5U types;
Measurements conditions are the same as for Capacitance measurement.

DIELECTRIC STRENGTH:

Parts are subjected for up to 5 seconds @ 25°C to : 250% of Rated Voltage

INSULATION RESISTANCE:

When measured @ 25°C and Rated Voltage, the following Minimum Values will be met: 100 Gig Ω or 1000 Ω F (whichever is less) for C0G and X7R types, 10 Gig Ω or 1000 Ω F (whichever is less) for Z5U types.

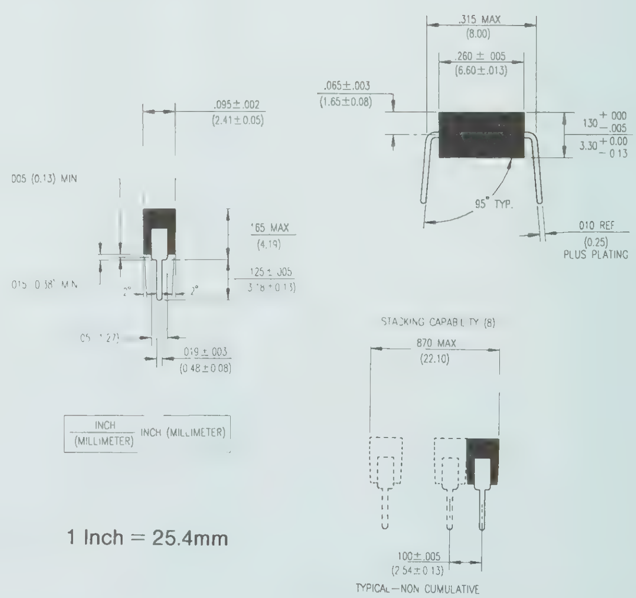
OPERATING TEMPERATURE RANGE

−55°C to +125°C for C0G and X7R
−55°C to +85°C for Z5U

ENCAPSULATION:

Molded Epoxy

DIMENSIONS:



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Mono-Pak® Dual In-Line Multilayer Capacitors

P 102 M 26 Z5U F VP WA

P Mono-Pak Product Line

CAPACITANCE VALUE
First two digits are significant, third digit is a multiplier as follows:
0 x 1
1 x 10
2 x 100
3 x 1000
4 x 10000
5 x 100000
6 x 1000000

Tolerance Code:
J ± 5% (C0G Only)
K ± 10% (C0G and X7R)
M ± 20% (X7R and Z5U)
P +100/−0% (Z5U)
Z +80/−20% (Z5U)

26 .260" ±.020 Long
.093/.098" Wide
.135" Max Height

C0G OPPM ±30PPM from −55°C to +125°C
X7R ±15% Max Cap change from −55°C to ±125°C
Z5U +22 to −56% Max Cap change from +10°C to +85°C.

Note: 1 inch = 25.4 mm

VP Magazine Pack,
200/Magazine
25 Magazines/Box
Inserts on
.300" Centers

F 50VDC
C0G, X7R, Z5U
H 100VDC
C0G, X7R, Z5U
K 200VDC
C0G, X7R

Cap Value in Mfd.	Min. IR in MegΩ	Detail Code
≤ .01	100000	WA
.012	84000	WB
.015	67000	WC
.018	56000	WD
.022	46000	WE
.027	37000	WF
.033	31000	WG
.039	26000	WH
.047	22000	WJ
.056	18000	WK
.068	15000	WL
.082	12000	WM
.100	10000	WN
.120	8400	WP
.150	6700	WR
.180	5600	WS
.220	4600	WT
.27	3700	WU
.33	3100	WW
.39	2600	WX
.47	2200	WY
.56	1800	XA
.68	1500	XB
.82	1200	XC
1.0	1000	XD
1.5	670	XE
2.2	460	XF
2.7	370	XG
3.3	310	XH
4.7	220	XJ
5.6	180	XK
6.8	150	XL
8.2	120	XM
10	100	XN

SERIES P

Mono-Pak® Dual In-Line Ceramic Multilayer Capacitors

STANDARD STOCK LISTING

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	SIZE CODE	LEAD SPACING
50 Volt DCW C0G (NPO)					
10 pf	P100K26C0GFVPWA	CN80C100KM	±10	26	.300"
22 pf	P220K26C0GFVPWA	CN80C220KM	±10	26	.300"
33 pf	P330K26C0GFVPWA	CN80C330KM	±10	26	.300"
47 pf	P470K26C0GFVPWA	CN80C470KM	±10	26	.300"
56 pf	P560K26C0GFVPWA	CN80C560KM	±10	26	.300"
68 pf	P680K26C0GFVPWA	CN80C680KM	±10	26	.300"
82 pf	P820K26C0GFVPWA	CN80C820KM	±10	26	.300"
100 pf	P101K26C0GFVPWA	CN80C101KM	±10	26	.300"
150 pf	P151K26C0GFVPWA	CN80C151KM	±10	26	.300"
220 pf	P221J26C0GFVPWA	CN80C221JM	±5	26	.300"
220 pf	P221K26C0GFVPWA	CN80C221KM	±10	26	.300"
330 pf	P331K26C0GFVPWA	CN80C331KM	±10	26	.300"
470 pf	P471K26C0GFVPWA	CN80C471KM	±10	26	.300"
.001 μf	P102J26C0GFVPWA	CN80C102JM	±5	26	.300"
.001 μf	P102K26C0GFVPWA	CN80C102KM	±10	26	.300"
.0022 μf	P222K26C0GFVPWA	CN80C222KM	±10	26	.300"
50 Volt DCW X7R					
.0033 μf	P332K26X7RFVPWA	CW80C332KM	±10	26	.300"
.0047 μf	P472K26X7RFVPWA	CW80C472KM	±10	26	.300"
.01 μf	P103K26X7RFVPWA	CW80C103KM	±10	26	.300"
.01 μf	P103M26X7RFVPWA	CW80C103MM	±20	26	.300"
.022 μf	P223K26X7RFVPWE	CW80C223KM	±10	26	.300"
.022 μf	P223M26X7RFVPWE	CW80C223MM	±20	26	.300"
.047 μf	P473K26X7RFVPWJ	CW80C473KM	±10	26	.300"
.047 μf	P473M26X7RFVPWJ	CW80C473MM	±20	26	.300"
.1 μf	P104K26X7RFVPWN	CW80C104KM	±10	26	.300"
.1 μf	P104M26X7RFVPWN	CW80C104MM	±20	26	.300"
.22 μf	P224K26X7RFVPWT	CW80C224KM	±10	26	.300"
.22 μf	P224M26X7RFVPWT	CW80C224MM	±20	26	.300"
50 Volt DCW Z5U					
.01 μf	P103M26Z5UFVPWA	CZ80C103MM	±20	26	.300"
.01 μf	P103Z26Z5UFVPWA	CZ80C103ZM	+80-20	26	.300"
.022 μf	P223M26Z5UFVPWE	CZ80C223MM	±20	26	.300"
.022 μf	P223Z26Z5UFVPWE	CZ80C223ZM	+80-20	26	.300"
.047 μf	P473M26Z5UFVPWJ	CZ80C473MM	±20	26	.300"
.047 μf	P473Z26Z5UFVPWJ	CZ80C473ZM	+80-20	26	.300"
.1 μf	P104M26Z5UFVPWN	CZ80C104MM	±20	26	.300"
.1 μf	P104Z26Z5UFVPWN	CZ80C104ZM	+80-20	26	.300"
.22 μf	P224M26Z5UFVPWT	CZ80C224MM	±20	26	.300"
.22 μf	P224Z26Z5UFVPWT	CZ80C224ZM	+80-20	26	.300"
.33 μf	P334Z26Z5UFVPWW	CZ80C334ZM	+80-20	26	.300"

STANDARD MARKING:

VMCCCT

V = VOLTAGE CODE
Blank = 50V
1 = 100V
2 = 200V

M = MATERIAL CODE (EIA TC CODE)
A = C0G (NPO)
C = X7R
E = Z5U

CCC = CODED CAPACITANCE VALUE
10pF through 99pF: actual value in pF (2 digits only)
100pF and above: coded cap. value, same as used in P/N on the Spec.

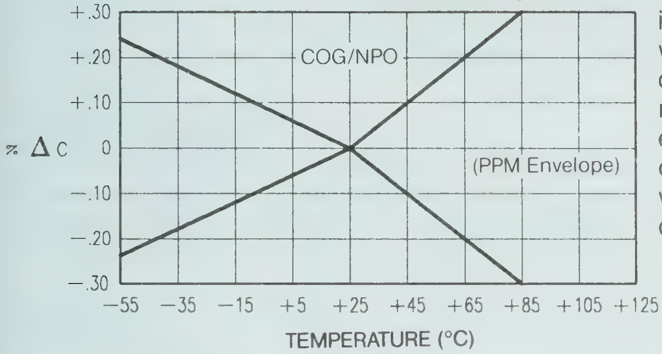
T = TOLERANCE CODE; SAME AS USED IN THE P/N
Use "VP" for Mechanical Detail Code for all Mono-Pak (they are packaged 200 to a Magazine).

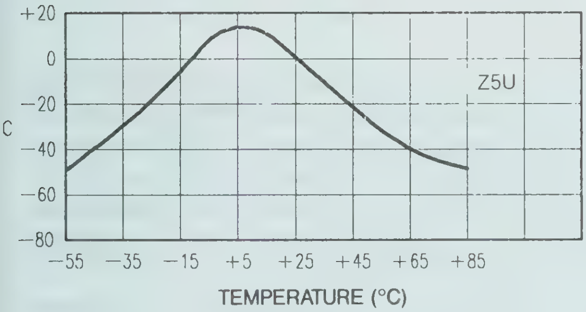
Standard Qty is 5000 pcs (25 magazines) in a carton.

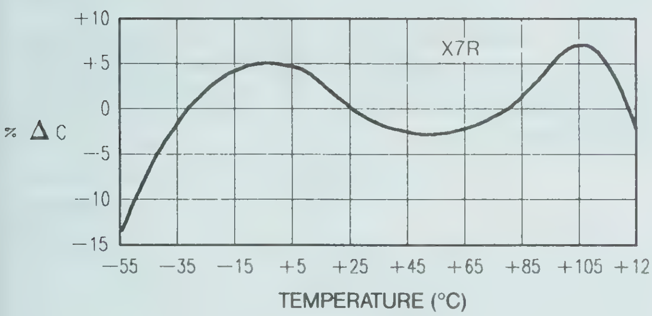
Monolithic Multilayer Capacitors

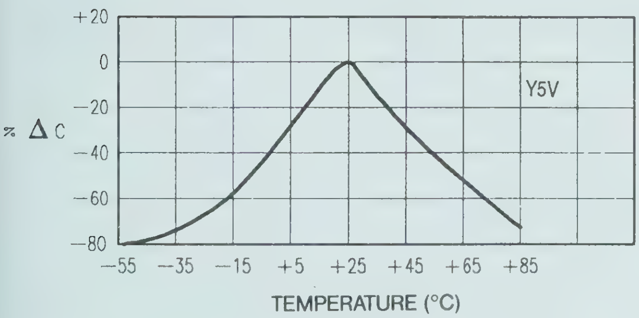
Philips Components monolithic ceramic capacitors were originally developed to improve the volumetric efficiency of ceramic capacitors. Ceramic materials are processed into a tape with a typical thickness range from 1 to 3 millimeters. Metal electrode patterns are applied using a thick film screening process. Multiple layers are stacked and laminated in such a manner that electrodes are alternately exposed when the pattern is cut into individual chip capacitors. The capacitors are fired through a high temperature profile to mature the ceramic and metal into a homogeneous unit. Metal end terminations are applied and fired to provide electrical connection between the individual layers. A full range of values from 1 pF to 10 μF is available in four EIA dielectric designations.

CAPACITANCE CHANGE (△C) vs TEMPERATURE

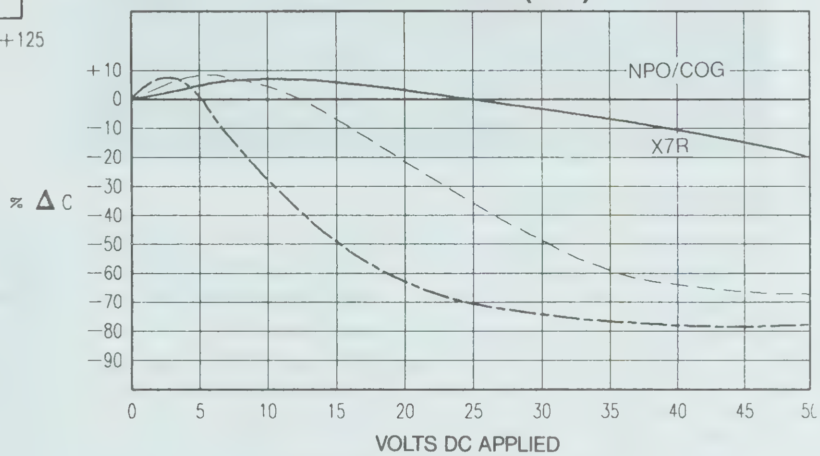




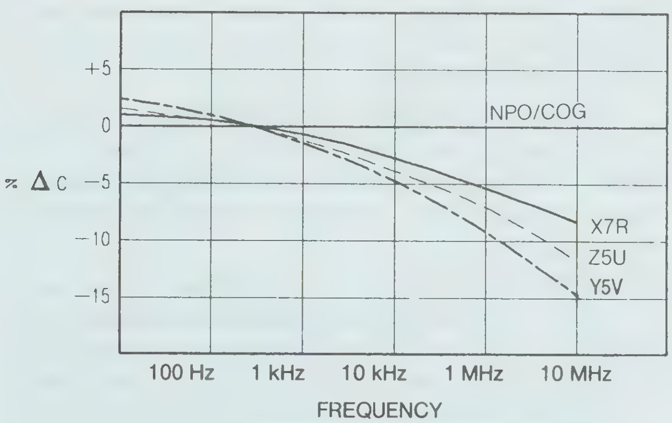




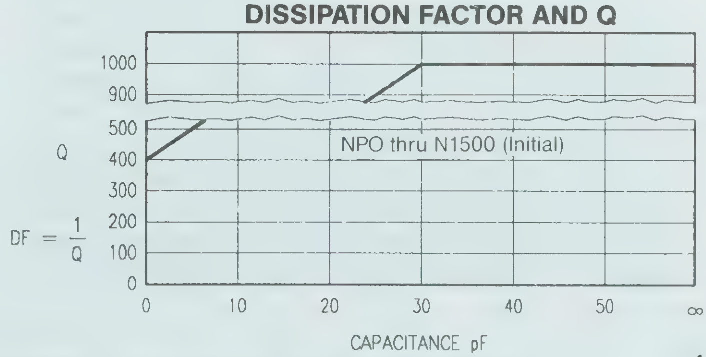
CAPACITANCE CHANGE (△C) vs DC VOLTAGE (50V)



CAPACITANCE CHANGE (△C) vs FREQUENCY

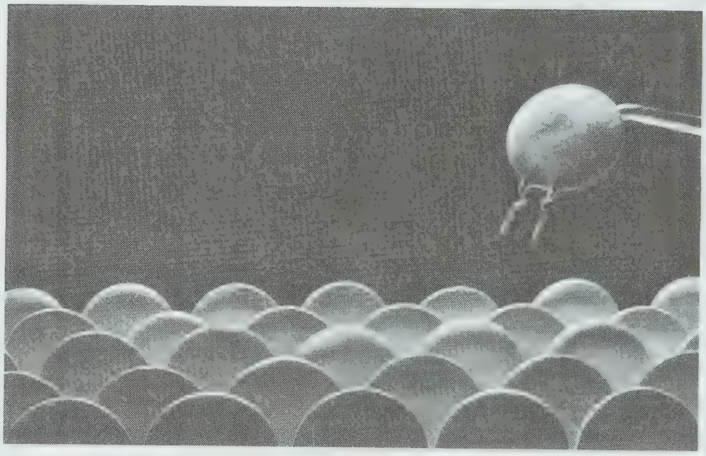


DISSIPATION FACTOR AND Q



SERIES D AND S

50VDC through 6KVDC, EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors



DESCRIPTION:

Our General Purpose and Temperature Stable capacitors are available with DC Voltage ratings as high as 6KV. They may be subdivided into five different groupings of Standard Stock Items:

1. Low Voltage Standard Stock Items; This covers the range of 50VDC through 600VDC with Temperature Characteristics of Z5U and Z5V, they are typically used in non-critical bypass and coupling applications. Also included are Dual Capacitance units, which provide two capacitors within a single package, with a common center lead.
2. Temperature Stable Standard Stock Items: This covers a variety of 600VDC X5F and Z5P units. These items provide excellent temperature stability over a wide ambient temperature range.
3. Philips Components' Temperature Compensating Capacitors provide an accurate predictable linear capacitance change with variations in ambient temperature. This change is called Temperature Coefficient of Capacitance (TCC or TC) and is expressed in Parts-per-million-per-degree-Centigrade (PPM/°C). The Temperature Coefficient is determined from a two point measurement of the capacitance at +25°C and +85°C. The NPO (C0G) capacitor typical application includes tuned circuits, RF networks and other critical applications where the drift free performance of a temperature compensating capacitor is mandatory (NPO = 30PPM/°C).
4. 1 KDVC General Purpose Stock Items; This series provides a wide choice of 1000 Volt DC rated units for general purpose applications. These units are primarily designed for non-critical coupling, bypass and filter applications as found in all types of entertainment, industrial and medical equipment.
5. High Voltage Standard Stock Items: This series includes 1400VDC/150VAC units as well as 1600VDC, 3000VDC and 6000VDC units. These units are especially useful for filtering, blocking, voltage multiplier applications and for arc and noise suppression on switches, relays and motors.

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SERIES D AND S

50VDC through 6KVDC, EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors

CAPACITANCE:
Measured @ 1MHz @ 1.0 ± 0.2VRMS @ 25°C for values 1000 pF or less.

Measured @ 1MHz @ 1.0 ± 0.2VRMS @ 25°C for S2L and S3N Temperature Characteristics.

Measured @ 1KHz @ 1.0 ± 0.2VRMS @ 25°C for all others.

DISSIPATION FACTOR:
For Class I capacitors, dissipation factor is typically expressed as Q (Quality) Factor and is measured under the same conditions as capacitance.
Q = 1/DF or DF = 1/Q NPO (COG) = .1% DF.

.6% Max. when measured @ 1MHz @ 1.0 ± 0.2 VRMS @ 25°C for S2L and S3N Temperature Characteristics.

2.5% Max. when measured @ 1KHz @ 1.0 ± 0.2 VRMS @ 25°C for all others.

DIELECTRIC STRENGTH:
250% of Rated Voltage for units rated 500/600VDC or less, 200% of Rated Voltage for units rated 1KVDC, 175% of Rated Voltage for units rated over 1KVDC, with the test voltage being raised from zero to the specified value at a rate of approx. 500VDC per second and the maximum test voltage being maintained for 60 seconds; the limiting value of direct current shall be 50 milliAmps for both charging and discharging.

INSULATION RESISTANCE:
10,000 Meg Ω minimum when measured at rated Voltage or 500VDC, whichever is less, after 2 minutes, ±5 seconds charge time, with charging current limited to 50 milliAmps.

MARKING:
Philips Components Logo (Diamond Shape), Capacitance Value (in Micro-Farad), EIA Capacitance Tolerance Code, Rated Voltage, EIA Temperature Characteristic (in this order, as size permits). 50 Volt rated units may have capacitance value marking underlined to denote 50VDC rating.

ENCAPSULATION:
Phenolic Resin, Golden/Yellow colored for units less than 3000VDC, Epoxy, Golden colored for 3000VDC and higher, coating material is at Philips Components' option.

OPERATING TEMPERATURE RANGE
−55°C to +125°C.

PACKAGING:
Both Bulk and Radial Tape and Reel (per EIA RS-468) product available. Taped and Reeled product available on 2000 pc reels only.

LEADFORMS:
Taped and reeled product available with 5mm (.197″) nominal spacing, #24 AWG CCS or CU wire 5.08mm (.200″), 6.35mm (.350″), IKC (standard), SOL (.200 only) or SLC.

CERAMIC CAPACITOR PART NUMBER SYSTEM

Ceramic Disc Capacitors

D 102 K 29 Z5F N TH EM

D Disc Capacitors

CAPACITANCE VALUE
First two digits are significant, third digit is a multiplier as follows:
0 x 1
1 x 10
2 x 100
3 x 1000
4 x 10000
9 x .1

Tolerance Code:

C	± .25pF (<10pF)	Class I
D	± .5pF (<10pF)	Class I
F	± 1pF (<10pF)	Class I
H	± 3% (≥10pF)	Class I
J	± 5% (≥ 5pF)	Class I
K	± 10% (≥2.5pF)	Class I & II
M	± 20%	Class II & III
P	+100/−0% (GMV)	Class III
Z	+80/−20%	Class II & III

Code	Size
20	.197″ Dia x .156″ Thick
29	.290″ Dia x .156″ Thick
33	.330″ Dia x .203″ Thick
39	.394″ Dia x .156″ Thick
40	.400″ Dia x .156″ Thick
43	.430″ Dia x .203″ Thick
47	.472″ Dia x .156″ Thick
52	.520″ Dia x .203″ Thick
59	.590″ Dia x .156″ Thick
63	.630″ Dia x .203″ Thick
66	.660″ Dia x .313″ Thick
69	.690″ Dia x .156″ Thick
73	.730″ Dia x .203″ Thick
76	.760″ Dia x .313″ Thick
82	.820″ Dia x .156″ Thick
86	.860″ Dia x .203″ Thick
93	.930″ Dia x .156″ Thick
96	.960″ Dia x .203″ Thick

Note: Above Numbering System is for STANDARD PRODUCT.

Note: 1 inch = 25.4mm

Temperature Characteristic per EIA RS-198 for Class II & III

First Digit is Lower Temperature	Second Digit is Highest Temperature	Third Digit is Percent Change Allowed
X −55°C	4 +65°C	F ± 7.5%
Y −30°C	5 +85°C	P ± 10%
Z +10°C	6 +105°C	R ± 15%
	7 +125°C	S ± 22%
	8 +150°C	T +22/−33%
		U +22/−56%
		V +22/−82%

Changes in Capacitance are all using the 25°C Cap. Value as reference Point.

Temperature Characteristic per EIA RS-198 for Class I

First 2 Digits		Last Digit defines the TC Tolerance as follows:	
C0	NPO	G	30PPM
U1	N080	H	60PPM
P2	N150	J	120PPM
R2	N220	K	250PPM
S2	N330	L	500PPM
T2	N470	M	1000PPM
U2	N750	N	2500PPM
P3	N1500		
R3	N2200		
S3	N3300		

F	50VDC	P	2KVDC
G	75VDC	R	3KVDC
H	100VDC	S	4KVDC
J	150VDC	T	5KVDC
K	200VDC	U	6KVDC
L	600VDC	X	1.6KVDC
N	1KVDC		

Class I

Code	Dielectric Strength Tested @
AA	1500VDC
AB	2 X Rated VDC
AC	500VDC
AN	1300VDC

Class II & III

Code	Dielectric Strength Tested @
ED	1500VDC
EM	2 X Rated VDC
EP	1300VDC
EU	500VDC

Code	Space	Length	Wire Dia.	Form	Pack
AA	.250″	1.0″ Min	#22	SLL	Bulk
AB	.375″	1.0″ Min	#22	SLL	Bulk
BE	.250″	.187″	#22	SLC	Bulk
BF	.375″	.187″	#22	SLC	Bulk
CE	.250″	.187″	#22	BBC	Bulk
CF	.375″	1.87″	#22	BBC	Bulk
EA	.250″	1.0″ Min	#22	SOL	Bulk
EB	.375″	1.0″ Min	#22	SOL	Bulk
FE	.250″	.187″	#22	IKC	Bulk
FF	.375″	.187″	#22	IKC	Bulk
GE	.250″	.187″	#22	OKC	Bulk
GF	.375″	.187″	#22	OKC	Bulk
MA	.200″	1.0″ Min	#22	SLL	Bulk
MB	.200″	1.0″ Min	#24	SLL	Bulk
TE	.250″	H-18MM	#24	SLC	Tape & Reel
TF	.250″	Ho-16MM	#24	IKC	Tape & Reel
TH	.200″	Ho-16MM	#24	IKC	Tape & Reel
TK	.200″	Ho-16MM	#24	SOL	Tape & Reel
TM	.200″	Ho-16MM	#24	SLC	Tape & Reel

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SERIES D AND S

50VDC through 6KVDC, EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors

RANGE CHARTS

EIA Class I COG Disc Capacitors
Numbers reflect smallest STD Philips Components disc sizes.

		NPO/COG		
Standard Tolerance		Tol. 5%, 10%		
Standard Elect. Code		AC	AA	AB
Voltage		100	500	1KV
EIA CAPACITANCE VALUE CODE	159	20	20	20
	189	20	20	20
	229	20	20	20
	279	20	20	20
	339	20	20	20
	399	20	20	20
	479	20	20	20
	569	20	20	20
	689	20	20	20
	829	20	20	20
	919	20	20	20
	100	20	20	20
	120	20	20	20
	150	20	20	20
	180	20	20	20
	220	20	20	20
	270	20	29	29
	330	29	29	29
	390	29	29	29
	470	29	40	40
	560	29	40	40
	680	29	40	40
	820	40	40	40
	910	40	40	40
	101	40	40	40
	121	40	47	47
	151	40	59	59
	181	47	59	59
	221	47	59	59
	271	59	69	69
	331	59	82	82
	391	69	82	82

Size Codes:	
20	.197" dia, .156" thick
29	.290" dia, .156" thick
39	.394" dia, .156" thick
40	.405" dia, .156" thick
47	.472" dia, .156" thick
59	.590" dia, .156" thick
69	.690" dia, .156" thick
82	.820" dia, .156" thick
93	.930" dia, .156" thick

EIA Class II and III Disc Capacitors:

Use the following chart to determine which Ceramic to use in order to obtain the desired Temperature Characteristics for Class II and III capacitors.

EIA TC	Maximum Capacitance Change Allowed	*	Temp. Range	Use Ceramic	Standard Avail. Tol.
X5F	+/−7.5%	*	−55°C to +85°C	T27 only	+/−10, +/−20%
X5P	+/−10%		−55°C to +85°C	T4 or T27	+/−10, +/−20%
X5R	+/−15%		−55°C to +85°C	T4 or T27	+/−10, +/−20%
X5S	+/−22%		−55°C to +85°C	T4 or T27	+/−10, +/−20%
X5T	+22/−33%		−55°C to +85°C	T4 or T27	+/−10, +/−20%
X5U	+22/−56%		−55°C to +85°C	T4, T27 or T32	+/−20, +80-20%
X5V	+ 22/−82%		−55°C to +85°C	T4, T27 or T32	+/−20, +80-20%
X7S	+/−22%		−55°C to +125°C	T27 only	+/−10, +/−20%
X7T	+22/−33%		−55°C to +125°C	T4 or T27	+/−20, +80-20%
X7U	+22/−56%		−55°C to +125°C	T4, T27 or T32	+/−20, +80-20%
X7V	+22/−82%		−55°C to +125°C	T4, T27 or T32	+/−20, +80-20%
Y5E	+/−4.7%		−30°C to +85°C	T27 only	+/−10, +/−20%
Y5F	+/−7.5%		−30°C to +85°C	T27 only	+/−10, +/−20%
Y5P	+/−10%	*	−30°C to +85°C	T4 or T27	+/−10, +/−20%
Y5R	+/−15%		−30°C to +85°C	T4 or T27	+/−10, +/−20%
Y5S	+/−22%		−30°C to +85°C	T4 or T27	+/−10, +/−20%
Y5T	+22/−33%		−30°C to +85°C	T4 or T27	+/−20, +80-20%
Y5U	+22/−56%		−30°C to +85°C	T4, T27 or T32	+/−20, +80-20%
Y5V	+22/−82%		−30°C to +85°C	T4, T27, T32 or T66	+/−20, +80-20%
Z5E	+/−4.7%		+10°C to +85°C	T27 only	+/−10, +/−20%
Z5F	+/−7.5%		+10°C to +85°C	T4 or T27	+/−10, +/−20%
Z5P	+/−10%	*	+10°C to +85°C	T4 or T27	+/−10, +/−20%
Z5R	+/−15%		+10°C to +85°C	T4 or T27	+/−10, +/−20%
Z5S	+/−22%		+10°C to +85°C	T4 or T27	+/−10, +/−20%
Z5T	+22/+33%		+10°C to +85°C	T4 or T27	+/−20, +80-20%
Z5U	+22/−56%	*	+10°C to +85°C	T4, T27, T32 or T66	+/−20, +80-20%
Z5V	+22/−82%	*	+10°C to +85°C	Any One Listed.	+/−20, +80-20%

* STANDARD Temperature Characteristics

After selecting ceramic see following pages to determine size from charts.

Special Sizes (Dual Disc Construction)

S62 .620" ida, .220" thick (Epoxy or Phenolic Coated, CRL option)

S72 .720" dia, .220" thick (Epoxy or Phenolic Coated, CRL option)

S85 .850" dia, .220" thick (Epoxy or Phenolic Coated, CRL option)

S95 .950" dia, .220" thick (Epoxy or Phenolic Coated, CRL option)

Note:
Voltages indicated are maximum operating voltages; use 100V column for 50V, etc.

SERIES D AND S

50VDC through 6KVDC, EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors

How to use the Class II and Class III Selector Chart:

1. Look up the EIA TC Code required, or look up the Maximum Change in Capacitance Value over a certain Temperature Range allowed by the Circuit.
2. This will provide one (or more) Ceramic(s).
3. Now use the range chart and find the intersection of the capacitance Value desired and the Voltage desired (within the previously selected Ceramic).
4. The number found is the smallest size on which this product may be supplied.

An Example:

Requirements: 2200 pF +/−10%, Y5S, 100VDC, no larger than .500.″ We find that for Y5S we can use either T4 or T27 Ceramic. In the Range Chart, we find at the intersection of EIA Cap Code 222 and T27 Ceramic/100V, that "40" is listed. (Nothing is listed under T4 for this Cap Code, so that the T27 Ceramic is the only choice.) This means that the above described part can be supplied on a diameter of .394″ Maximum, well within the .500″ requirement. Where multiple Ceramics meet the same TC requirements, typically the smallest sizes are found under the Ceramic with the highest number.

CLASS II AND CLASS III DISC CAPACITORS

CLASS II; TC tolerance 〈 ±22% (E, F, P, R)
CLASS III; TC tolerance = 〉 ±22% (S, T, U, V)

	EIA CLASS II									EIA CLASS III					
Common Electrical	T4 CERAMIC			T27 CERAMIC			T32 CERAMIC			T66 CERAMIC			T82 CER.	
P/N Code	EU	ED	EM	EU	ED	EM	EU	ED	EM	EU	ED	EM	EU	ED
Voltage	100	500	1KV	100	500	1KV	100	500	1KV	100	500	1KV	100	500
CODED CAPACITANCE VALUE														
680	20	20	20											
820	20	20	20											
101	20	20	20											
121				20	20	20								
151				20	20	20								
181				20	20	20								
221				20	20	20								
271				20	20	20								
331				20	20	20								
391				20	20	20								
471				20	20	20								
561				20	29	29	20	20	20					
681				20	29	29	20	20	20					
821				29	29	29	20	29	29		20	20		
102				29	29	29	20	29	29		20	20		
122				29	40	40	20	29	29		20	29		
152				29	40	40	29	29	29	20	29	29		
182				40	40	40	29	40	40	20	29	29		
202				40	40	40	29	40	40	20	29	29		
222				40	40	40	29	40	40	20	29	40		
272				40	47	47	29	40	40	29	29	40	20	
302				40	47	47	29	40	40	29	40	40	20	
332				40	47	47	40	40	40	29	40	40	29	
392				40	59	59	40	47	47	29	40	40	29	
472				47	59	59	40	47	47	29	40	40	29	
502				47	59	59	40	47	47	29	40	47	29	
562				59	69	69	40	59	59	40	40	59	29	
682				59	69	69	40	59	59	40	40	59	40	

Continued

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SERIES D AND S

50VDC through 6KVDC, EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors

CLASS II; TC tolerance 〈 ±22% (E, F, P, R)
CLASS III; TC tolerance = 〉 ±22% (S, T, U, V)

	EIA CLASS II								EIA CLASS III					
Common Electrical	T4 CERAMIC			T27 CERAMIC			T32 CERAMIC			T66 CERAMIC			T82 CER.	
P/N Code	EU	ED	EM	EU	ED	EM	EU	ED	EM	EU	ED	EM	EU	ED
Voltage	**100**	**500**	**1KV**	**100**	**500**	**1KV**	**100**	**500**	**1KV**	**100**	**500**	**1KV**	**100**	**500**
CODED CAPACITANCE VALUE 822				59	82	82	47	69	69	40	47	59	40	
103				69	82	82	47	69	69	40	47	59	40	
123					93	93	59	82	82	40	59	69	40	59
153							59	82	93	47	59	69	47	59
183										47	69	82	47	69
203										59	69	82	59	69
223										59	69	82	59	69
273										59	69	S72	59	69
303										69	S72	S85	69	S72
333										69	S72	S85	69	S72
393										69	S72	S85	69	S72
473										69	S72	S95	69	S72
503										69	S72	S95	69	S72
563										S62	S85		S62	S72
683										S62	S85		S62	S85
823										S72	S95		S72	S95
104										S72	S95		S72	S95

SERIES D AND S

50VDC through 6KVDC, EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors

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Ceramic Capacitors

STANDARD STOCK ITEMS

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	TC CODE	MAX. DIA.	MAX. THICK.	LEAD SPACE	LEAD STYLE
50 Volt DCW								
.005 µf	D502Z29Z5VFAAEU	CK502	+80-20%	Z5V	.29″	.156″	.250″	SLL
.01 µf	D103Z39Z5VFAAEU	CK103	+80-20%	Z5V	.39″	.156″	.250″	SLL
.01 µf	D103Z39Z5VFTHEU	–	+80-20%	Z5V	.39″	.140″	.200″	IKC*
.02 µf	D203Z59Z5VFABEU	CK203	+80-20%	Z5V	.59″	.156″	.375″	SLL
.025 µf	D253Z59Z5VFABEU	CK253	+80-20%	Z5V	.59″	.156″	.375″	SLL
.03 µf	D303Z59Z5VFABEU	CK303	+80-20%	Z5V	.59″	.156″	.375″	SLL
.05 µf	D503Z69Z5VFABEU	CK503	+80-20%	Z5V	.69″	.156″	.375″	SLL
.1 µf	S104Z72Z5VFAZAA	CK104	+80-20%	Z5V	.72″	.171″	.375″	SLL
75 Volt DCW								
.05 µf	D503X69Z5VGAZAA	DDA503	+80-30%	Z5V	.69″	.156″	.375″	SLL
.1 µf	S104X72Z5VGAZAA	DDA104	+80-30%	Z5V	.72″	.171″	.375″	SLL
100 Volt DCW								
.005 µf	D502M39Z5VHAAEU	DC502	±20%	Z5V	.39″	.156″	.250″	SLL
.005 µf	D502M39Z5VHBEEU	XXDC502	±20%	Z5V	.39″	.156″	.250″	SLC
.01 µf	D103M39Z5VHAAEU	DC103	±20%	Z5V	.39″	.156″	.250″	SLL
.01 µf	D103M39Z5VHBEEU	XXDC103	±20%	Z5V	.39″	.156″	.250″	SLC
.01 µf	D103M39Z5VHTHEU	–	±20%	Z5V	.39″	.140″	.200″	IKC*
.02 µf	D203M59Z5VHABEU	DC203	±20%	Z5V	.59″	.156″	.375″	SLL
.02 µf	D203M59Z5VHBFEU	XXDC203	±20%	Z5V	.59″	.156″	.375″	SLC
.025 µf	D253M59Z5VHABEU	DC253	±20%	Z5V	.59″	.156″	.375″	SLL
.025 µf	D253M59Z5VHBFEU	XXDC253	±20%	Z5V	.59″	.156″	.375″	SLC
.05 µf	D503M69Z5VHABEU	DC503	±20%	Z5V	.69″	.156″	.375″	SLL
.05 µf	D503M69Z5VHBFEU	XXDC503	±20%	Z5V	.69″	.156″	.375″	SLC
.1 µf	S104M72Z5VHAZAA	DC104	±20%	Z5V	.72″	.171″	.375″	SLL
.1 µf	S104S72Z5VHAZAA	DC104S	±30%	Z5V	.72″	.171″	.375″	SLL
100 Volt DCW C0G (NPO)								
10 pf	D100J20C0GHMBAC	–	±5%	C0G	.20″	.138″	.200″	SLL
22 pf	D220J20C0GHMBAC	–	±5%	C0G	.20″	.138″	.200″	SLL
27 pf	D270J20C0GHMBAC	–	±5%	C0G	.20″	.138″	.200″	SLL
33 pf	D330J20C0GHMBAC	–	±5%	C0G	.20″	.138″	.200″	SLL
47 pf	D470J29C0GHMBAC	–	±5%	C0G	.29″	.138″	.200″	SLL
68 pf	D680J29C0GHMBAC	–	±5%	C0G	.29″	.138″	.200″	SLL
82 pf	D820J40C0GHMBAC	–	±5%	C0G	.40″	.138″	.200″	SLL
100 pf	D101J40C0GHMBAC	–	±5%	C0G	.40″	.138″	.200″	SLL
600 Volt DCW								
.01 µf	D103P59Z5ULABED	DD6103	GMV	Z5U	.59″	.156″	.375″	SLL
.015 µf	D153Z69Z5ULABED	DD153	+80-20%	Z5U	.69″	.156″	.375″	SLL
.02 µf	D203Z69Z5ULABED	DD203	+80-20%	Z5U	.69″	.156″	.375″	SLL
.02 µf	D203Z69Z5ULBFED	XXDD203	+80-20%	Z5U	.69″	.156″	.375″	SLC
.03 µf	S303Z72Z5ULAZAA	DD303	+80-20%	Z5U	.72″	.250″	.375″	SLL
.04 µf	S403Z72Z5ULAZAA	DD403	+80-20%	Z5U	.72″	.250″	.375″	SLL
.05 µf	S503Z85Z5ULAZAA	DD503	+80-20%	Z5U	.85″	.250″	.375″	SLL
.05 µf	S503Z85Z5ULBFED	XXDD503	+80-20%	Z5U	.85″	.250″	.375″	SLC
.1 µf	S104Z95Z5VLAZAB	DD104	+80-20%	Z5U	.95″	.250″	.375″	SLL

*Tape and Reel Packaging

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STANDARD STOCK ITEMS

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	TC CODE	MAX. DIA.	MAX. THICK.	LEAD SPACE	LEAD STYLE
600 Volt DCW C0G (NPO)								
1.5 pf	D159D20C0KLAAAA	DTZ1R5	±0.5pf	C0K	.20″	.156″	.250″	SLL
2.2 pf	D229D20C0KLAAAA	DTZ2R2	±0.5pf	C0K	.20″	.156″	.250″	SLL
3.3 pf	D339D20C0JLAAAA	DTZ3R3	±0.5pf	C0J	.20″	.156″	.250″	SLL
4.7 pf	D479D20C0JLAAAA	DTZ4R7	±0.5pf	C0J	.20″	.156″	.250″	SLL
6.8 pf	D689D20C0HLAAAA	DTZ6R8	±0.5pf	C0H	.20″	.156″	.250″	SLL
10 pf	D100J20C0GLAAAA	DTZ10	±5%	C0G	.20″	.156″	.250″	SLL
15 pf	D150J20C0GLAAAA	DTZ15	±5%	C0G	.20″	.156″	.250″	SLL
18 pf	D180J20C0GLAAAA	—	±5%	C0G	.20″	.156″	.250″	SLL
20 pf	D200J20C0GLAAAA	DTZ20	±5%	C0G	.20″	.156″	.250″	SLL
22 pf	D220J29C0GLAAAA	DTZ22	±5%	C0G	.29″	.156″	.250″	SLL
25 pf	D250J29C0GLAAAA	DTZ25	±5%	C0G	.29″	.156″	.250″	SLL
27 pf	D270J29C0GLAAAA	—	±5%	C0G	.29″	.156″	.250″	SLL
33 pf	D330J29C0GLAAAA	DTZ33	±5%	C0G	.29″	.156″	.250″	SLL
47 pf	D470J40C0GLAAAA	DTZ47	±5%	C0G	.40″	.156″	.250″	SLL
50 pf	D500J40C0GLAAAA	DTZ50	±5%	C0G	.40″	.156″	.250″	SLL
68 pf	D680J40C0GLAAAA	DTZ68	±5%	C0G	.40″	.156″	.250″	SLL
75 pf	D750J40C0GLABAA	DTZ75	±5%	C0G	.40″	.156″	.375″	SLL
82 pf	D820J40C0GLABAA	DTZ82	±5%	C0G	.40″	.156″	.375″	SLL
100 pf	D101J40C0GLABAA	DTZ100	±5%	C0G	.40″	.156″	.375″	SLL
120 pf	D121J47C0GLABAA	DTZ120	±5%	C0G	.47″	.156″	.375″	SLL
150 pf	D151J59C0GLABAA	DTZ150	±5%	C0G	.59″	.156″	.375″	SLL
200 pf	D201J59C0GLABAA	DTZ200	±5%	C0G	.59″	.156″	.375″	SLL
220 pf	D221J59C0GLABAA	DTZ220	±5%	C0G	.59″	.156″	.375″	SLL
Dual Capacitance 600 Volt DCW								
.001 µf	S102P39Z5ULAZAA	DD3102	GMV	Z5U	.39″	.186″	.125″	SLL
.005 µf	S502P59Z5ULAZAA	DD3502	GMV	Z5U	.59″	.225″	.125″	SLL
.01 µf	S103P69Z5ULAZAA	DD3103	GMV	Z5U	.69″	.225″	.125″	SLL
600 Volt DCW X5F								
150 pf	D151K20X5FLAAEC	CE151	±10%		.20″	.156″	.250″	SLL
220 pf	D221K20X5FLAAEC	CE221	±10%		.20″	.156″	.250″	SLL
330 pf	D331K20X5FLAAEC	CE331	±10%		.20″	.156″	.250″	SLL
470 pf	D471K20X5FLAAEC	CE471	±10%		.20″	.156″	.250″	SLL
500 pf	D501K20X5FLAAEC	CE501	±10%		.20″	.156″	.250″	SLL
560 pf	D561K29X5FLAAEA	CE561	±10%		.29″	.156″	.250″	SLL
680 pf	D681K29X5FLAAEA	CE681	±10%		.29″	.156″	.250″	SLL
750 pf	D751K29X5FLAAEA	CE751	±10%		.29″	.156″	.250″	SLL
800 pf	D801K29X5FLAAEC	CE801	±10%		.29″	.156″	.250″	SLL
820 pf	D821K29X5FLAAEC	CE821	±10%		.29″	.156″	.250″	SLL
.001 µf	D102K29X5FLAAEC	CE102	±10%		.29″	.156″	.250″	SLL
.0012 µf	D122K39X5FLAAEC	CE122	±10%		.39″	.156″	.250″	SLL
.0015 µf	D152K39X5FLAAEC	CE152	±10%		.39″	.156″	.250″	SLL
.0018 µf	D182K39X5FLAAEC	CE182	±10%		.39″	.156″	.250″	SLL

SERIES D AND S

50VDC through 6KVDC,EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors

STANDARD STOCK ITEMS

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	TC CODE	MAX. DIA.	MAX. THICK.	LEAD SPACE	LEAD STYLE
600 Volt DCW X5F (continued)								
.002 μf	D202K39X5FLAAEC	CE202	±10%	X5F	.39″	.156″	.250″	SLL
.0022 μf	D222K39X5FLAAEC	CE222	±10%	X5F	.39″	.156″	.250″	SLL
.0033 μf	D332K47X5FLABEC	CE332	±10%	X5F	.47″	.156″	.375″	SLL
.0039 μf	D392K59X5FLABEC	CE392	±10%	X5F	.59″	.156″	.375″	SLL
.0047 μf	D472K59X5FLABEC	CE472	±10%	X5F	.59″	.156″	.375″	SLL
.005 μf	D502K69X5FLABED	CE502	±10%	X5F	.69″	.156″	.375″	SLL
.0062 μf	D622K69X5FLABED	CE622	±10%	X5F	.69″	.156″	.375″	SLL
.0082 μf	D822K82X5FLABEC	CE822	±10%	X5F	.82″	.156″	.375″	SLL
.01 μf	D103K82X5FLABEA	CE103	±10%	X5F	.82″	.156″	.375″	SLL
600 Volt DCW Z5P								
.0012 μf	D122K39Z5PLAAED	CF122	±10%	Z5P	.39″	.156″	.250″	SLL
.0015 μf	D152K39Z5PLAAED	CF152	±10%	Z5P	.39″	.156″	.250″	SLL
.0018 μf	D182K39Z5PLAAED	CF182	±10%	Z5P	.39″	.156″	.250″	SLL
.002 μf	D202K39Z5PLAAED	CF202	±10%	Z5P	.39″	.156″	.250″	SLL
.0022 μf	D222K39Z5PLAAEC	CF222	±10%	Z5P	.39″	.156″	.250″	SLL
.0033 μf	D332K47Z5PLAAED	CF332	±10%	Z5P	.47″	.156″	.250″	SLL
.0039 μf	D392K59Z5PLABED	CF392	±10%	Z5P	.59″	.156″	.375″	SLL
.0047 μf	D472K59Z5PLABED	CF472	±10%	Z5P	.59″	.156″	.375″	SLL
.005 μf	D502K59Z5PLABED	CF502	±10%	Z5P	.59″	.156″	.375″	SLL
.0062 μf	D622K69Z5PLABED	CF622	±10%	Z5P	.69″	.156″	.375″	SLL
.0082 μf	D822K82Z5PLABED	CF822	±10%	Z5P	.82″	.156″	.375″	SLL
.01 μf	D103K82Z5PLABED	CF103	±10%	Z5P	.82″	.156″	.375″	SLL

50VDC through 6KVDC, EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors

STANDARD STOCK ITEMS

CAP. VALUE	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	TC CODE	MAX. DIA.	MAX. THICK.	LEAD SPACE	LEAD STYLE
1000 Volt DCW								
3.3 pf	D339D20S2LNAAAL	DD3R3	±0.5%	S2L	.20"	.156"	.250"	SLL
5 pf	D509K20S2LNAAAL	DD050	±10%	S2L	.20"	.156"	.250"	SLL
6 pf	D609K20S2LNAAAL	DD060	±10%	S2L	.20"	.156"	.250"	SLL
6.8 pf	D689K20S2LNAAAL	DD6R8	±10%	S2L	.20"	.156"	.250"	SLL
7 pf	D709K20S2LNAAAL	DD070	±10%	S2L	.20"	.156"	.250"	SLL
8 pf	D809K20S2LNAAAL	DD080	±10%	S2L	.20"	.156"	.250"	SLL
10 pf	D100K20S2LNAAAL	DD100	±10%	S2L	.20"	.156"	.250"	SLL
12 pf	D120K20S2LNAAAL	DD120	±10%	S2L	.20"	.156"	.250"	SLL
15 pf	D150K20S2LNAAAL	DD150	±10%	S2L	.20"	.156"	.250"	SLL
18 pf	D180K20S2LNAAAL	DD180	±10%	S2L	.20"	.156"	.250"	SLL
20 pf	D200K20S2LNAAAL	DD200	±10%	S2L	.20"	.156"	.250"	SLL
22 pf	D220K20S2LNAAAL	DD220	±10%	S2L	.20"	.156"	.250"	SLL
24 pf	D240K20S2LNAAAL	DD240	±10%	S2L	.20"	.156"	.250"	SLL
25 pf	D250K20S2LNAAAL	DD250	±10%	S2L	.20"	.156"	.250"	SLL
27 pf	D270K20S2LNAAAL	DD270	±10%	S2L	.20"	.156"	.250"	SLL
30 pf	D300K29S2LNAAAL	DD300	±10%	S2L	.29"	.156"	.250"	SLL
33 pf	D330K29S2LNAAAL	DD330	±10%	S2L	.29"	.156"	.250"	SLL
39 pf	D390K29S2LNAAAL	DD390	±10%	S2L	.29"	.156"	.250"	SLL
47 pf	D470K29S2LNAAAL	DD470	±10%	S2L	.29"	.156"	.250"	SLL
50 pf	D500K29S3NNAAAL	DD500	±10%	S3N	.29"	.156"	.250"	SLL
51 pf	D510K29S3NNAAAL	DD510	±10%	S3N	.29"	.156"	.250"	SLL
56 pf	D560K29S3NNAAAL	DD560	±10%	S3N	.29"	.156"	.250"	SLL
68 pf	D680K29S3NNAAAL	DD680	±10%	S3N	.29"	.156"	.250"	SLL
75 pf	D750K29S3NNAAAL	DD750	±10%	S3N	.29"	.156"	.250"	SLL
82 pf	D820K29S3NNAAAL	DD820	±10%	S3N	.29"	.156"	.250"	SLL
91 pf	D910K29S3NNAAAL	DD910	±10%	S3N	.29"	.156"	.250"	SLL
100 pf	D101K29S3NNAAAL	DD101	±10%	S3N	.29"	.156"	.250"	SLL
100 pf	D101K29S3NNBEAL	XXDD101	±10%	S3N	.29"	.156"	.250"	SLC
100 pf	D101K29S3NNTHAL	—	±10%	S3N	.29"	.156"	.200"	IKC*
120 pf	D121K29S3NNAAAL	DD121	±10%	S3N	.29"	.156"	.250"	SLL
130 pf	D131K29S3NNAAAL	DD131	±10%	S3N	.29"	.156"	.250"	SLL
150 pf	D151K29S3NNAAAL	DD151	±10%	S3N	.29"	.156"	.250"	SLL
180 pf	D181K29S3NNAAAL	DD181	±10%	S3N	.29"	.156"	.250"	SLL
200 pf	D201K29S3NNAAAL	DD201	±10%	S3N	.29"	.156"	.250"	SLL
200 pf	D201K29S3NNBEAB	XXDD201	±10%	S3N	.29"	.156"	.250"	SLC
220 pf	D221K20Z5FNAAEM	DD221	±10%	Z5F	.20"	.156"	.250"	SLL
220 pf	D221K20Z5FNBEEM	XXDD221	±10%	Z5F	.20"	.156"	.250"	SLC
240 pf	D241K20Z5FNAAEM	DD241	±10%	Z5F	.20"	.156"	.250"	SLL
250 pf	D251K20Z5FNAAEM	DD251	±10%	Z5F	.20"	.156"	.250"	SLL
270 pf	D271K20Z5FNAAEM	DD271	±10%	Z5F	.20"	.156"	.250"	SLL
300 pf	D301K20Z5FNAAEM	DD301	±10%	Z5F	.20"	.156"	.250"	SLL
330 pf	D331K20Z5FNAAEM	DD331	±10%	Z5F	.20"	.156"	.250"	SLL
350 pf	D351K20Z5FNAAEM	DD351	±10%	Z5F	.20"	.156"	.250"	SLL
360 pf	D361K20Z5FNAAEM	DD361	±10%	Z5F	.20"	.156"	.250"	SLL
390 pf	D391K20Z5FNAAEM	DD391	±10%	Z5F	.20"	.156"	.250"	SLL
400 pf	D401K20Z5FNAAEM	DD401	±10%	Z5F	.20"	.156"	.250"	SLL

*Tape and Reel Packaging

SERIES D AND S

50VDC through 6KVDC, EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors

STANDARD STOCK ITEMS

CAP. VALUE	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	TC CODE	MAX. DIA.	MAX. THICK.	LEAD SPACE	LEAD STYLE
1000 Volt DCW								
470 pf	D471K20Z5FNAAEM	DD471	±10%	Z5F	.20″	.156″	.250″	SLL
470 pf	D471K20Z5FNBEEM	XXDD471	±10%	Z5F	.20″	.156″	.250″	SLC
500 pf	D501K29Z5FNAAEM	DD501	±10%	Z5F	.29″	.156″	.250″	SLL
500 pf	D501K29Z5FNBEEM	XXDD501	±10%	Z5F	.29″	.156″	.250″	SLC
510 pf	D511K29Z5FNAAEM	DD511	+10%	Z5F	.29″	.156″	.250″	SLL
560 pf	D561K29Z5FNAAEM	DD561	±10%	Z5F	.29″	.156″	.250″	SLL
600 pf	D601K29Z5RNAAEM	DD601	±10%	Z5R	.29″	.156″	.250″	SLL
680 pf	D681K29Z5RNAAEM	DD681	±10%	Z5R	.29″	.156″	.250″	SLL
750 pf	D751K29Z5RNAAEM	DD751	±10%	Z5R	.29″	.156″	.250″	SLL
820 pf	D821K29Z5FNAAEM	DD821	±10%	Z5F	.29″	.156″	.250″	SLL
910 pf	D911K29Z5RNAAEM	DD911	±10%	Z5R	.29″	.156″	.250″	SLL
.001 µf	D102K29Z5FNAAEM	DD102	±10%	Z5F	.29″	.156″	.250″	SLL
.001 µf	D102K29Z5FNBEEM	XXDD102	±10%	Z5F	.29″	.156″	.250″	SLC
.001 µf	D102K29Z5FNTHEM	–	±10%	Z5F	.29″	.156″	.200″	IKC*
.001 µf	D102P29Z5UNAAEM	DD102G	GMV	Z5U	.29″	.156″	.250″	SLL
.001 µf	D102P29Z5UNBEEM	XXDD102G	GMV	Z5U	.29″	.156″	.250″	SLC
.0012 µf	D122K39Z5RNAAEM	DD122	+10%	Z5R	.39″	.156″	.250″	SLL
.0013 µf	D132K39Z5RNAAEM	DD132	±10%	Z5R	.39″	.156″	.250″	SLL
.0015 µf	D152K39Z5RNAAEM	DD152	±10%	Z5R	.39″	.156″	.250″	SLL
.0015 µf	D152P29Z5UNAAEM	DD152G	GMV	Z5U	.29″	.156″	.250″	SLL
.0016 µf	D162K39Z5RNAAEM	DD162	±10%	Z5R	.39″	.156″	.250″	SLL
.0018 µf	D182K39Z5RNAAEM	DD182	±10%	Z5R	.39″	.156″	.250″	SLL
.002 µf	D202M39Z5UNAAEM	DD202	±20%	Z5U	.39″	.156″	.250″	SLL
.002 µf	D202M39Z5UNBEEM	XXDD202	±20%	Z5U	.39″	.156″	.250″	SLC
.0022 µf	D222M39Z5UNAAEM	DD222	±20%	Z5U	.39″	.156″	.250″	SLL
.0025 µf	D252M39Z5UNAAEM	DD252	±20%	Z5U	.39″	.156″	.250″	SLL
.0027 µf	D272M39Z5UNAAEM	DD272	±20%	Z5U	.39″	.156″	.250″	SLL
.003 µf	D302M39Z5UNAAEM	DD302	±20%	Z5U	.39″	.156″	.250″	SLL
.0033 µf	D332M39Z5UNAAEM	DD332	±20%	Z5U	.39″	.156″	.250″	SLL
.0039 µf	D392M39Z5UNAAEM	DD392	±20%	Z5U	.39″	.156″	.250″	SLL
.004 µf	D402M39Z5UNAAEM	DD402	±20%	Z5U	.39″	.156″	.250″	SLL
.0043 µf	D432M47Z5UNAAEM	DD432	±20%	Z5U	.47″	.156″	.250″	SLL
.0047 µf	D472M47Z5UNAAEM	DD472	±20%	Z5U	.47″	.156″	.250″	SLL
.005 µf	D502M47Z5UNAAEM	DD5022	±20%	Z5U	.47″	.156″	.250″	SLL
.005 µf	D502P59Z5UNABEM	DD502	GMV	Z5U	.59″	.156″	.375″	SLL
.005 µf	D502P59Z5UNBFEM	XXDD502	GMV	Z5U	.59″	.156″	.375″	SLC
.0056 µf	D562M47Z5UNAAEM	DD562	±20%	Z5U	.47″	.156″	.250″	SLL
.0068 µf	D682M59Z5UNABEM	DD682	±20%	Z5U	.59″	.156″	.375″	SLL
.0075 µf	D752M59Z5UNABEM	DD752	±20%	Z5U	.59″	.156″	.375″	SLL
.0082 µf	D822M59Z5UNABEM	DD822	±20%	Z5U	.59″	.156″	.375″	SLL
.01 µf	D103M59Z5UNABEM	DD1032	±20%	Z5U	.59″	.156″	.375″	SLL
.01 µf	D103P69Z5UNABEM	DD103	GMV	Z5U	.69″	.156″	.375″	SLL
.01 µf	D103P69Z5UNBFEM	XXDD103	GMV	Z5U	.69″	.156″	.375″	SLC

*Tape and Reel Packaging

SERIES D AND S

50VDC through 6KVDC, EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors

STANDARD STOCK ITEMS

CAP. VALUE	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	TC CODE	MAX. DIA.	MAX. THICK.	LEAD SPACE	LEAD STYLE
1400 Volt DCW/150 Volt AC RMS, 60Hz								
.0047 μf	D472M82Z5UYAZAA	DI472	±20%	Z5U	.82″	.240″	.375″	SLL
.01 μf	D103M82Z5UYAZAA	DI103	±20%	Z5U	.82″	.180″	.375″	SLL
1600 Volt DCW								
.003 μf	D302P59Z5UXAZAA	DD16302	GMV	Z5U	.59″	.172″	.375″	SLL
.005 μf	D502P59Z5UXAZAA	DD16502	GMV	Z5U	.59″	.172″	.375″	SLL
.006 μf	D602P69Z5UXAZAA	DD16602	GMV	Z5U	.69″	.172″	.375″	SLL
.007 μf	D702P69Z5UXAZAA	DD16702	GMV	Z5U	.69″	.172″	.375″	SLL
.01 μf	D103P82Z5UXAZAA	DD16103	GMV	Z5U	.82″	.172″	.375″	SLL
.015 μf	D153Z93Z5UXAZAA	DD16153	+80−20%	Z5U	.93″	.172″	.375″	SLL
3000 Volt DCW								
4.7 pf	D479M33S2LRAAAL	DD304R7	±20%	S2L	.33″	.180″	.250″	SLL
10 pf	D100M33S2LRAAAL	DD30100	±20%	S2L	.33″	.180″	.250″	SLL
15 pf	D150M33S2LRAAAL	DD30150	±20%	S2L	.33″	.180″	.250″	SLL
22 pf	D220M33S3NRAAAL	DD30220	±20%	S3N	.33″	.180″	.250″	SLL
30 pf	D300M33S3NRAAAL	DD30300	±20%	S3N	.33″	.203″	.250″	SLL
33 pf	D330M33S3NRAAAL	DD30330	±20%	S3N	.33″	.203″	.250″	SLL
47 pf	D470M33S3NRAAAL	DD30470	±20%	S3N	.33″	.203″	.250″	SLL
50 pf	D500M33S3NRAAAL	DD30500	±20%	S3N	.33″	.203″	.250″	SLL
68 pf	D680M33S3NRAAAL	DD30680	±20%	S3N	.33″	.203″	.250″	SLL
82 pf	D820M33S3NRAAAL	DD30820	±20%	S3N	.33″	.203″	.250″	SLL
100 pf	D101M33Z5URAAEM	DD30101	±20%	Z5U	.33″	.203″	.250″	SLL
150 pf	D151M33Z5URAAEM	DD30151	±20%	Z5U	.33″	.203″	.250″	SLL
200 pf	D201M33Z5URAAEM	DD30201	±20%	Z5U	.33″	.203″	.250″	SLL
220 pf	D221M33Z5URAAEM	DD30221	±20%	Z5U	.33″	.203″	.250″	SLL
250 pf	D251M33Z5URAAEM	DD30251	±20%	Z5U	.33″	.203″	.250″	SLL
270 pf	D271M33Z5URAAEM	DD30271	±20%	Z5U	.33″	.203″	.250″	SLL
300 pf	D301M33Z5URAAEM	DD30301	±20%	Z5U	.33″	.203″	.250″	SLL
330 pf	D331M33Z5URAAEM	DD30331	±20%	Z5U	.33″	.203″	.250″	SLL
390 pf	D391M33Z5URAAEM	DD30391	±20%	Z5U	.33″	.203″	.250″	SLL
470 pf	D471M33Z5URAAEM	DD30471	±20%	Z5U	.33″	.203″	.250″	SLL
500 pf	D501M33Z5URAAEM	DD30501	±20%	Z5U	.33″	.203″	.250″	SLL
680 pf	D681M33Z5URAAEM	DD30681	±20%	Z5U	.33″	.203″	.250″	SLL
750 pf	D751M33Z5URAAEM	DD30751	±20%	Z5U	.33″	.203″	.250″	SLL
820 pf	D821M43Z5URAAEM	DD30821	±20%	Z5U	.43″	.203″	.250″	SLL
.001 μf	D102M43Z5URAAEM	DD30102	±20%	Z5U	.43″	.203″	.250″	SLL
.0012 μf	D122M43Z5URAAEM	DD30122	±20%	Z5U	.43″	.203″	.250″	SLL
.0015 μf	D152M63Z5URABEM	DD30152	±20%	Z5U	.63″	.203″	.375″	SLL
.002 μf	D202M63Z5URABEM	DD30202	±20%	Z5U	.63″	.203″	.375″	SLL
.0022 μf	D222M63Z5URABEM	DD30222	±20%	Z5U	.63″	.203″	.375″	SLL
.0027 μf	D272M63Z5URABEM	DD30272	±20%	Z5U	.63″	.203″	.375″	SLL
.003 μf	D302M63Z5URABEM	DD30302	±20%	Z5U	.63″	.203″	.375″	SLL
.0033 μf	D332M63Z5URABEM	DD30332	±20%	Z5U	.63″	.203″	.375″	SLL
.0039 μf	D392M73Z5URABEM	DD30392	±20%	Z5U	.73″	.203″	.375″	SLL
.0047 μf	D472M73Z5URABEM	DD30472	±20%	Z5U	.73″	.203″	.375″	SLL
.005 μf	D502M73Z5URABEM	DD30502	±20%	Z5U	.73″	.203″	.375″	SLL
.01 μf	D103M96Z5URABEM	DD30103	±20%	Z5U	.96″	.203″	.375″	SLL

SERIES D AND S

50VDC through 6KVDC, EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors

STANDARD STOCK ITEMS

2

Ceramic Capacitors

CAP. VALUE	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	TC CODE	MAX. DIA.	MAX. THICK.	LEAD SPACE	LEAD STYLE
6000 Volt DCW								
10 pf	D100M66S2LUABAL	DD60100	±20%	S2L	.66″	.313″	.375″	SLL
15 pf	D150M66S2LUABAL	DD60150	±20%	S2L	.66″	.313″	.375″	SLL
30 pf	D300M66S3NUABAL	DD60300	±20%	S3N	.66″	.313″	.375″	SLL
39 pf	D390M66S3NUABAL	DD60390	±20%	S3N	.66″	.313″	.375″	SLL
47 pf	D470M66S3NUABAL	DD60470	±20%	S3N	.66″	.313″	.375″	SLL
50 pf	D500M66S3NUABAL	DD60500	±20%	S3N	.66″	.313″	.375″	SLL
75 pf	D750M66S3NUABAL	DD60750	±20%	S3N	.66″	.313″	.375″	SLL
82 pf	D820M66S3NUABAL	DD60820	±20%	S3N	.66″	.313″	.375″	SLL
100 pf	D101M66S3NUAZAA	DD60101	±20%	S3N	.66″	.313″	.375″	SLL
120 pf	D121M66S3NUABAL	DD60121	±20%	S3N	.66″	.313″	.375″	SLL
150 pf	D151M66S3NUABAL	DD60151	±20%	S3N	.66″	.313″	.375″	SLL
180 pf	D181M66Z5UUABEM	DD60181	±20%	Z5U	.66″	.313″	.375″	SLL
200 pf	D201M66Z5UUABEM	DD60201	±20%	Z5U	.66″	.313″	.375″	SLL
220 pf	D221M66Z5UUABEM	DD60221	±20%	Z5U	.66″	.313″	.375″	SLL
250 pf	D251M66Z5UUABEM	DD60251	±20%	Z5U	.66″	.313″	.375″	SLL
300 pf	D301M66Z5UUABEM	DD60301	±20%	Z5U	.66″	.313″	.375″	SLL
390 pf	D391M66Z5UUABEM	DD60391	±20%	Z5U	.66″	.313″	.375″	SLL
470 pf	D471M66Z5UUABEM	DD60471	±20%	Z5U	.66″	.313″	.375″	SLL
500 pf	D501M66Z5UUABEM	DD60501	±20%	Z5U	.66″	.313″	.375″	SLL
750 pf	D751M66Z5UUABEM	DD60751	±20%	Z5U	.66″	.313″	.375″	SLL
820 pf	D821M66Z5UUABEM	DD60821	±20%	Z5U	.66″	.313″	.375″	SLL
.001 μf	D102M66Z5UUABEM	DD60102	±20%	Z5U	.66″	.313″	.375″	SLL
.0012 μf	D122M66Z5UUABEM	DD60122	±20%	Z5U	.66″	.313″	.375″	SLL
.0015 μf	D152M66Z5UUABEM	DD60152	±20%	Z5U	.66″	.313″	.375″	SLL
.002 μf	D202M76Z5UUABEM	DD60202	±20%	Z5U	.76″	.313″	.375″	SLL
.0022 μf	D222M76Z5UUABEM	DD60222	±20%	Z5U	.76″	.313″	.375″	SLL

50VDC through 6KVDC, EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors

Standard Disc Leadforms

SLL

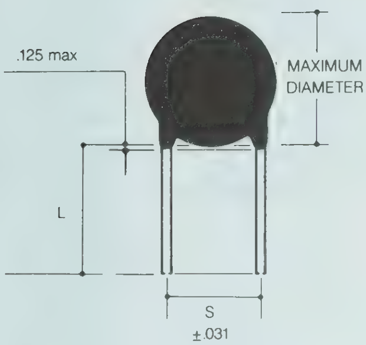

Fig 1 leadform available on all sizes and voltages, Bulk product only.

SLC

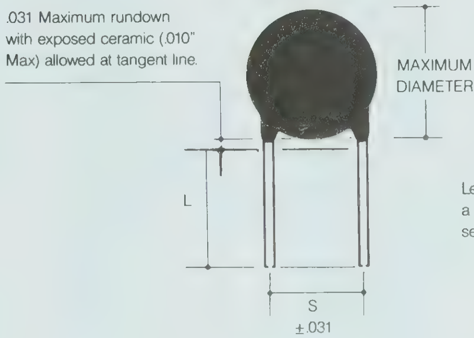

Fig 2 available on single disc construction, 1KV max rating, also avail. on Radial T & R.

SOL

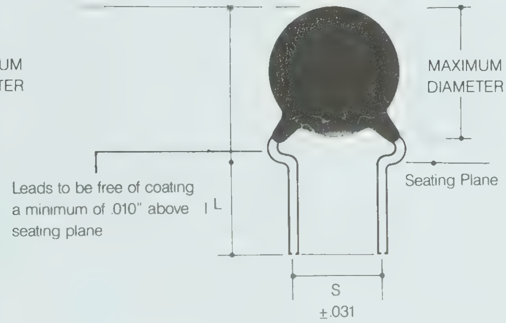

Fig 3 available on single disc construction, 1KV max rating, also avail. on Radial T & R.

OKC

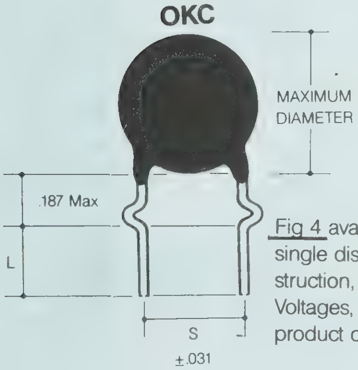

Fig 4 available on single disc construction, all Voltages, Bulk product only.

IKC

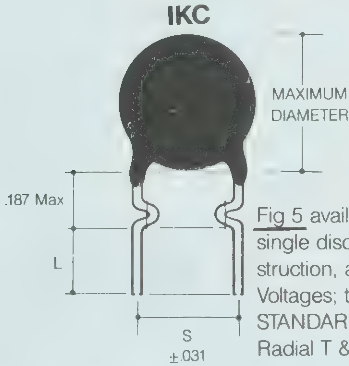

Fig 5 available on single disc construction, all Voltages; this is the STANDARD form for Radial T & R.

BBC

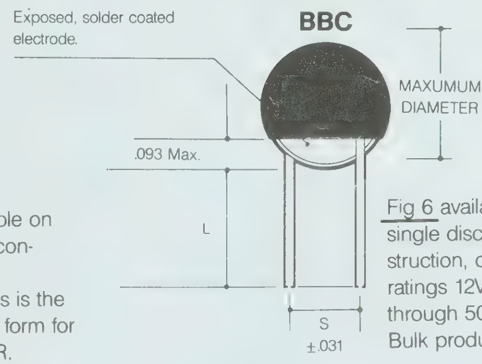

Fig 6 available on single disc construction, on Voltage ratings 12VDC through 500VDC, Bulk product only.

Note: 1 inch = 25.4 mm

Form	Definition
SLL =	Straight Lead, Standard
SLC =	Straight Lead, Controlled Run-down
SOL =	Stand Off Lead
OKC =	Outside Kink
IKC =	Inside Kink
BBC =	Bare Body Construction

SERIES D AND S

50VDC through 6KVDC, EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors

WIRE FORMS AND SPACINGS AVAILABLE BY DISC SIZE.

Packaging	LeadForm/ Figure	Spacing (S)	Length (L)	AWG/Dia	Available on Size	P/N Code
BULK	SLL/1	.197″	1.00 MIN	22/.025	20 thru 47	MA
	SLL/1	.197″	1.00 MIN	24/.020	20 thru 59	MB
	SLL/1	.250″	1.00 MIN	22/.025	20 thru 59	AA
	SLL/1	.375″	1.00 MIN	22/.025	29 thru 96	AB
	SLC/2	.197″	1.00 MIN	24/.020	20 thru 59	MD
	SLC/2	.197″	.197+.031/−.016	24/.020	20 thru 47	MF
	SLC/2	.250″	1.00 MIN	22/.025	20 thru 59	BA
	SLC/2	.250″	.187+.031/−.016	22/.025	20 thru 47	BE
	SLC/2	.375″	1.50 MIN	22/.025	29 thru 93	BB
	SLC/2	.375″	.187+.031/−.016	22/.025	29 thru 93	BF
	SOL/3	.197″	.197+.031/+.016	24/.020	20 thru 47	MM
	SOL/3	.250″	1.00 MIN	22/.025	20 thru 47	EB
	SOL/3	.250″	.165+.031/−.016	22/.025	20 thru 47	EG
	SOL/3	.250″	.187+.031/−.016	22/.025	20 thru 47	EE
	SOL/3	.375″	1.00 MIN	22/.025	29 thru 93	EA
	SOL/3	.375″	.165+.031/−.016	22/.025	29 thru 47	EH
	SOL/3	.375″	.187+.031/−.016	22/.025	29 thru 93	EF
	OKC/4	.250″	1.00 MIN	22/.025	20 thru 47	GC
	OKC/4	.250″	.187+.031/−.016	22/.025	29 thru 47	GE
	OKC/4	.375″	1.00 MIN	22/.025	40 thru 93	GD
	OKC/4	.375″	.187+.031/−.016	22/.025	59 thru 93	GF
	IKC/5	.197″	.197+.031/−.016	22/.025	20 thru 47	MT
	IKC/5	.250″	1.00 MIN	22/.025	20 thru 47	FC
	IKC/5	.250″	.187+.031/−.016	22/.025	20 thru 47	FE
	IKC/5	.375″	1.00 MIN	22/.025	59 thru 93	FD
	IKC/5	.375″	.187+.031/−.016	22/.025	59 thru 93	FF
	BBC/6	.250″	1.00 MIN	22/.025	20 thru 47	CA
	BBC/6	.250″	.165+.031/−.016	22/.025	20 thru 47	CN
	BBC/6	.250″	.187+.031/−.016	22/.025	20 thru 47	CE
	BBC/6	.375″	1.00 MIN	22/.025	59 thru 93	CB
	BBC/6	.375″	.165+.031/−.016	22/.025	59 thru 93	CP
	BBC/6	.375″	.187+.031/−.016	22/.025	20 thru 93	CF
RADIAL TAPE AND REEL	SLC/2	.197″	H IS 17 to 19.5MM	24/.020	20 thru 47	TM
	SOL/3	.197″	Ho IS 16 ± .5MM	24/.020	20 thru 47	TK
	IKC/5	.197″	Ho IS 16 ± .5MM	24/.020	20 thru 47	TH
	SLC/2	.250″	Ho IS 17 to 19.5MM	24/.020	20 thru 47	TE
	IKC/5	.250″	H IS 16 ± .5MM	24/.020	20 thru 47	TF

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DISC CAP TAPE & REEL

TAPE & REEL DIMENSIONS

DESCRIPTION	SYMBOL	METRIC DIMENSION	REFERENCE DIM'S IN INCHES
Body Diameter (Discs)	A	12,0Max	.476ref
Body Thickness	T	4,0Max	.157ref
Wire Lead Dia.	d	.45/.65	#24 AWG Cu.
Taping Pitch	P	12,7Ref	.500ref
Feed Hole Pitch (Note 1)	Po	12,7 ± 0,3 (Note 1)	.500ref
Feed Hole Off Alignment (200 L/5)	P1/P2	3,85 ± 0,7/6,35 ± 1,3	.152ref/.25ref
Feed Hole Off Alignment (.250 L/5)	P1/P2	3.10 ±0.6/6.35 ±1.3	.122 ± .024/.25 ±.051
Lead Spacing	F	5,0 + 0,8/−0.2 16.35 ± 0.7MM	.197ref/.250ref
Body Inclination	h	0 ± 1,0	0 ± .039ref
Carrier Tape Width	W	18,0 + 1,0/−0,5	.709ref
Adhesive Tape Width	Wo	13,0Ref	.512ref
Feed Hole Ht off Alignment	W1	9,0 + 0,75/−0,5	.354ref
Adhesive Tape Margin	W2	3,0 ± 3,0	.118ref
Straight Lead Height	H	17,0Min/19,5Max	.67/.76ref
Lead Crimp Height	Ho	16,0 ± 0,5	.63ref
Top of Component Height	H1	23,0Min/32,25Max	.91/1.27ref
Clean, Parallel Lead Length	H2	6,0ref	.236ref
Lead End Protrusion	1	2,0Max	.078ref
Feed Hole Diameter	Do	4,0 ± 0,3	.157ref
Overall Tape Thickness	t	0,9Max	.035ref
Rejected Component Cut Height	L	10,0Max	.394ref

Note: 1 Inch = 25.4 mm

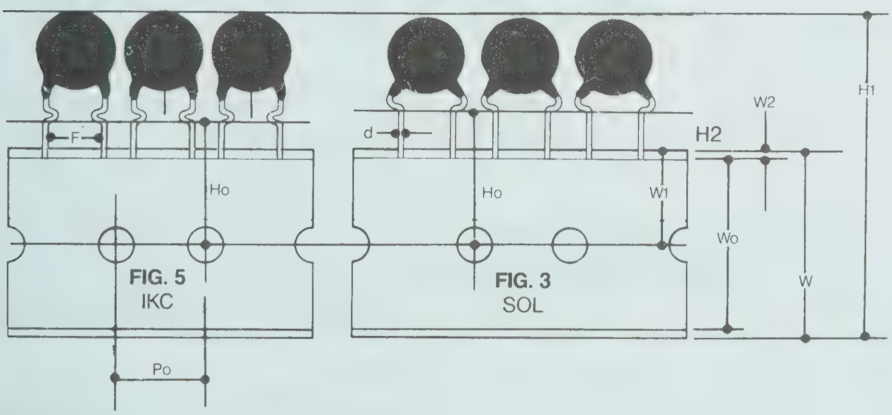


FIG. 5
IKC

FIG. 3
SOL

Note:
1. 1 Inch = 25.4mm
2. Cumulative pitch tolerance over 20 consecutive units not to exceed ±1.0mm.
3. Dimensions meet requirements defined in EIA RS468.
4. "H2" defines the useable portion of the lead for insertion equipment purposes: the leads in this area to be straight and parallel. They shall be @ 90°±3° to the top edge of the carrier tape and shall also be parallel to each other to within 3°. Deformation, if any, shall not exceed 3°.
H2 is the straight lead portion of any formed wire and the "Free of coating" area of any non-formed wire.

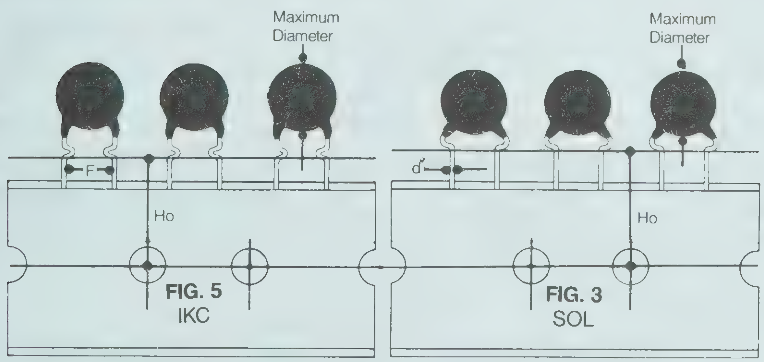


FIG. 5
IKC

FIG. 3
SOL

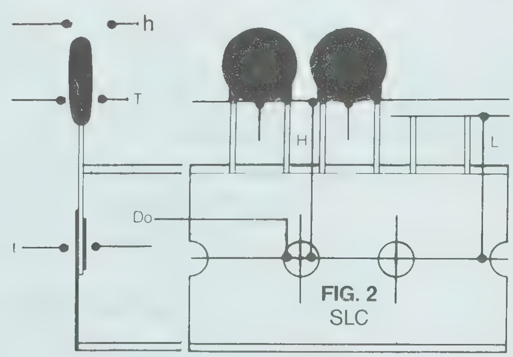


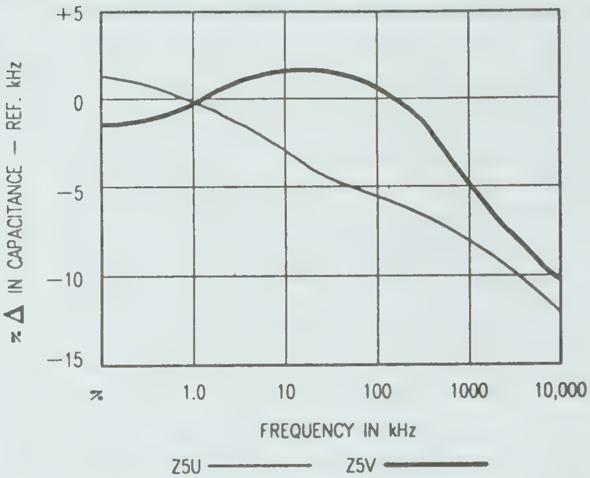
FIG. 2
SLC

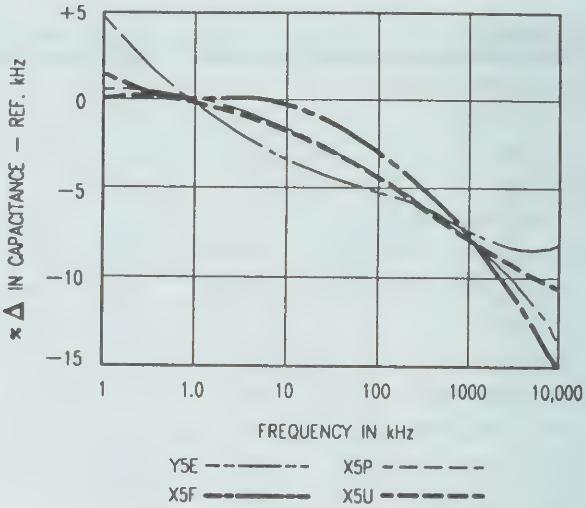
SERIES D AND S

50VDC through 6KVDC, EIA Class I, II and III, General Purpose and Temperature Stable, Ceramic Disc Capacitors

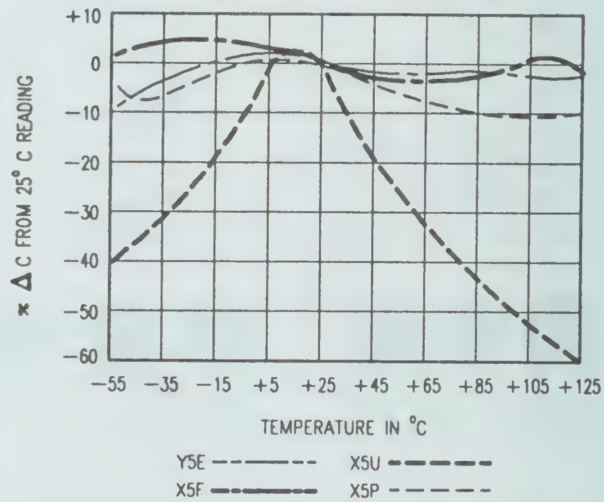
DISC CAPACITORS TYPICAL CHARACTERISTICS

CAPACITANCE VS FREQUENCY

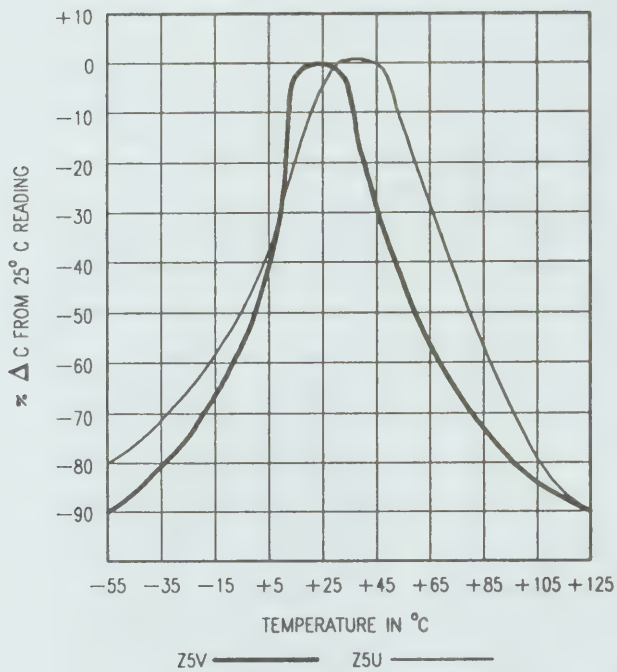




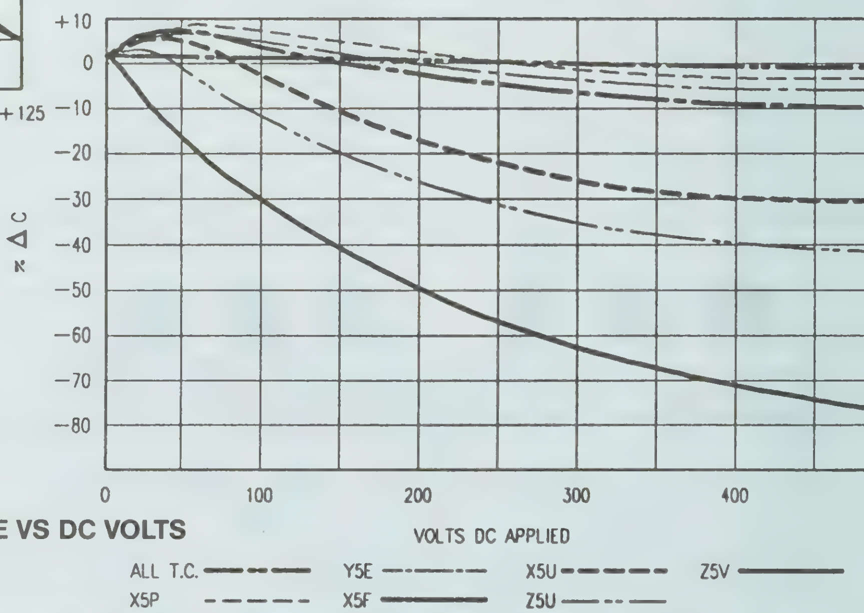
CAPACITANCE VS TEMPERATURE



CAPACITANCE VS TEMPERATURE



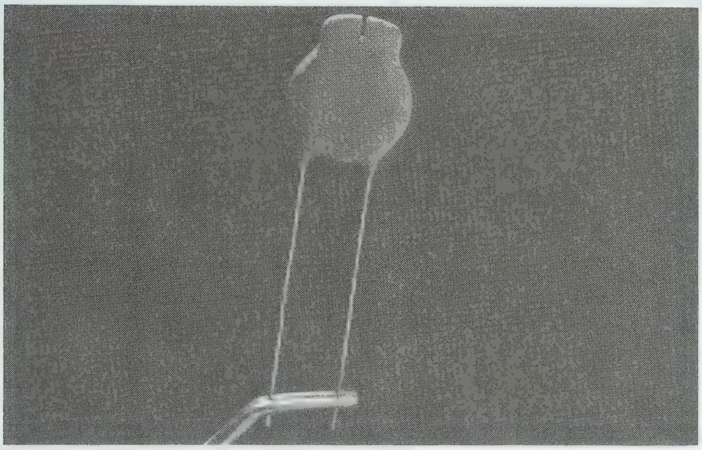
Note: Class I Dielectrics vary with temperature on a PPM/°C basis. See Chart on disc part number system page.



CAPACITANCE VS DC VOLTS

Philips Components • 7158 Merchant Avenue • El Paso, TX 79915 • (915) 775-4242 • FAX: (915) 775-4249

Gap-Kap®, 1000VDC through 3000VDC, Capacitor—Spark—Gap, Special Application Ceramic Capacitors



DESCRIPTION:

Series S Gap-Kap® capacitors provide a safe, reliable discharge path for stray transient over-voltages and static voltage build-up. Combination capacitor-spark-gap construction allows the circuit designer to specify lower voltage components and consequently lower cost, with the assurance that over-voltage conditions will be prevented.

The Gap-Kap® capacitor is ideally suited for many industrial and commercial equipment applications. A typical application in color TV, utilizes a minimum capacitance Gap-Kap® which is inserted between the grid lead and chassis ground. This protects the control components by providing a low impedance path to ground for transient voltages of 1500 volts and above.

SPECIFICATIONS:

CAPACITANCE RANGE:
.75pf to .02mf. Tested at 1.0±.2VRMS at 1KHz at +25°C.

CAPACITANCE TOLERANCE:
±10%. ±20% or Maximum Value, as listed.

WORKING VOLTAGE:
1000, 1500 or 3000 volts DC as listed.

ARC VOLTAGE:
1000-2000, 2000-3000 or 4000-6000 volts DC as listed.

DISSIPATION FACTOR:
2.5% Max. Tested at 1.0±.2VRMS at 1KHz at +25°C.

INSULATION RESISTANCE:
10,000 megohms minimum. Tested at 500 volts DC maximum.

TEMPERATURE CHARACTERISTIC:
EIA code Z5P or Z5U as listed. See "Capacitance vs. Temperature" for specifications.

OPERATING TEMPERATURE RANGE:
−55°C to +85°C

ENCAPSULATION:
Phenolic resin.

LEADS-CONFIGURATION:
Tinned wire. Type SLL, see drawing for dimensions.

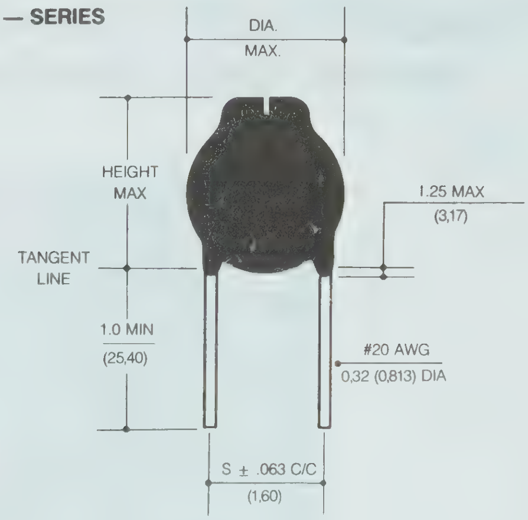
MARKING:
Philips Components diamond, Gap-Kap,® capacitance value, capacitance tolerance or code letter (K = ±10%, M = ±20%), working voltage, arc voltage and EIA temperature characteristic code as space permits GAP-R75 marked with arc voltage and trademarks only.

PACKAGING: Bulk Packed.

SERIES S

Gap-Kap,® 1000VDC through 3000VDC, Capacitor—Spark—Gap, Special Application Ceramic Capacitors

GAP — SERIES



STANDARD STOCK LISTING

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP TOL.	VOLTAGE WORKING KVDC	VOLTAGE ARC KVDC	TC CODE	MAX. DIA.	MAX. HT.	MAX. THICK	LEAD SPACE	LEAD STYLE
Spark-Gap Capacitor											
.75 pf	S758X44000NAZAA	GAPR75	Max Value	1	1-2	*	.44″	.620″	.250″	.250″	SLL
.001 mf	S102M40Z5PNAZAA	GAP102	±20%	1	2-3	Z5P	.40″	.545″	.195″	.250″	SLL
.004 mf	S402K96Z5PRAZAA	GAP402	±10%	3	4-6	Z5P	.96″	1.060″	.216″	.375″	SLL
.01 mf	S103M69Z5UNAZAB	GAP103	±20%	1.5	2-3	Z5U	.69″	.830″	.195″	.375″	SLL
.02 mf	S203M93Z5UNAZAA	GAP203	±20%	1	2-3	Z5U	.93″	1.060″	.216″	.375″	SLL

*Inherent capacitance of leads, no disc capacitor used.

Note: 1 Inch = 25.4 mm

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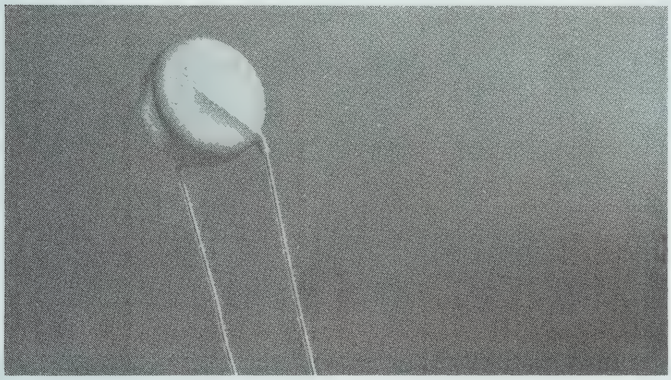
SERIES S-UL

125VAC, 250VAC, and 400VAC, UL, CSA, and VDE Listed Ceramic Disc Capacitors



Philips Components safety-recognized Ceramic AC Capacitors are designed especially for across-the-line, antenna-coupling and line-by-pass application.

SPECIFICATIONS:

ELECTRICAL:

Operating Temperature Range: −30°C to +85°C

Capacitance Range: 100 pF to 0.01μF
Tested at 1.0 ± 0.2V RMS, +25°C and 1KHz.

Capacitance Tolerance:
K = ±10% (100pF to 330pF)
M = ±20%
Z = +80% −20%

Working Voltage:
Type DL: 125/250/400VAC, 50/60Hz
Type DM: 125VAC, 50/60Hz

Dielectric Strength:
Type DL: 2500VAC for 60 seconds
Type DM: 1800VAC for 2 seconds

Dissipation Factor:
2.5% max. at 1.0 ± 0.2V RMS, +25°C and 1KHz

Insulation Resistance:
10,000 Megohms min. at 500VDC

Temperature Characteristics:
Z5P (also meet Y5P): 100pF up to 330pF
Z5U (also meet Y5V): over 330pF up to .01μF

Others: per UL/CSA/VDE standards

Type DL Capacitors:

UL: File No. E95439(N) per UL-1414, 250VAC
CSA: File No. LR61253−4 per CSA C22.2 class 2221 01, 125VAC
VDE: File No. 49936/49937 per VDE 0560 part 2/5.70, 400VAC

Type DM Capacitors:

UL : File No. E95439(N) per UL-1414, 125VAC
CSA : File No. LR61253−4 per CSA C22.2 class 2221 01, 125VAC
VDE : File No. 53134/55424, 125VAC

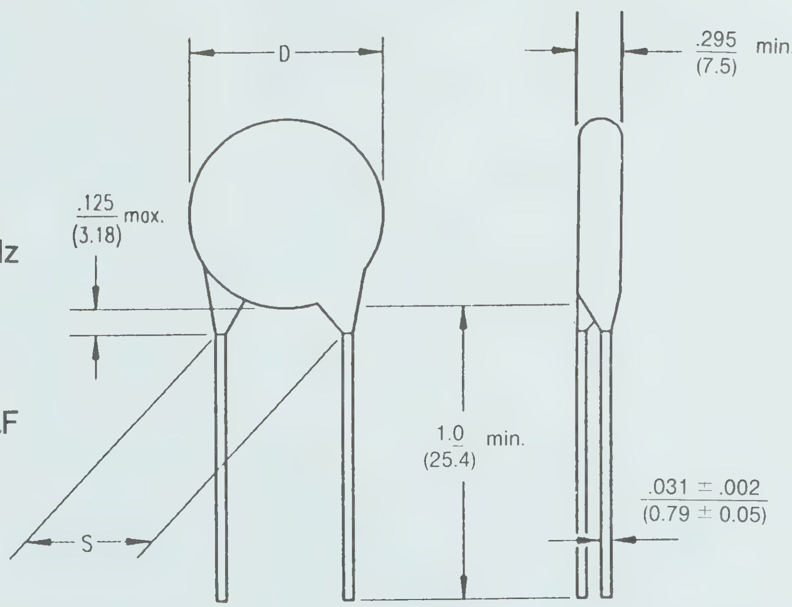
MECHANICAL:

Typical Marking:
Manufacturer's Identification
Capacitance and Tolerance
Type Designation
Safety Approval Mark

Encapsulation: Expoxy Resin, Flammability 94V-0

Disc Size and Lead Style:
See Figure Below

Note: 1 Inch = 25.4mm



INCH / (MILLIMETER)	INCH (MILLIMETER)

2

Ceramic Capacitors

CERAMIC CAPACITOR PART NUMBER SYSTEM
Special Application Series S-UL, CSA, VDE

S 102 M 43 Z5U Q AW ST

S Special Capacitors

CAPACITANCE VALUE
First two digits are significant, third digit is a multiplier as follows:
1 x 10
2 x 100
3 x 1000
Example:
102 = 10 x 100 = 1000 pF

Tolerance Code:
K ± 10%
M ± 20%
P +100/−0%
Z +80/−20%

33	.330″Dia x.240″Thick
43	.430″Dia x.240″Thick
52	.520″Dia x.240″Thick
66	.660″Dia x.240″Thick
73	.730″Dia x.240″Thick
76	.760″Dia x.240″Thick
79	.790″Dia x.240″Thick
86	.860″Dia x.240″Thick
96	.960″Dia x.203″Thick

Temperature Characteristic per EIA RS-198
Z5P ± 10% Max △C
Z5U +22/−56% Max △C
both over Temperature Range of +10°C to +85°C

Note: 1 inch = 25.4 mm

Q 250 VAC, 60Hz
Y 125 VAC, 60Hz
Note: Q used for 400 V per VDE.

AW Bulk, .250″ Spacing, 1.0″ Long, Tinned Copper, .032″ Dia Wire
AX Bulk, .375″ Spacing, 1.0″ Long, Tinned Copper, .032″ Dia Wire

ST UL/CSA/VDE Testing Performed

Note: Above Numbering System is for STANDARD PRODUCT.

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125VAC, 250VAC, and 400VAC, UL, CSA, and VDE Listed Ceramic Disc Capacitors

SERIES S-UL STANDARD STOCK LISTING*

CAPACITANCE		125 VOLT DL (DM) SERIES		250/400 VOLT DL SERIES	
Value	Tolerance	NEW PART NUMBER	DISTRIBUTOR PART NUMBER	NEW PART NUMBER	DISTRIBUTOR PART NUMBER
100 pF	± 10%	S101K33Z5PYAWST	DL 125-101 K	S101K33Z5PQAWST	DL 250-101 K
100 pF	± 20%	S101M33Z5PYAWST	DL 125-101 M	S101M33Z5PQAWST	DL 250-101 M
1000 pF	± 20%	S102M43Z5UYAWST	DL 125-102 M	S102M43Z5UQAWST	DL 250-102 M
1000 pF	+80-20%	S102Z43Z5UYAWST	DL 125-102 Z	S102Z43Z5UQAWST	DL 250-102 Z
10000 pF	± 20%	S103M96Z5UYAXST	DL 125-103 M	–	–
10000 pF	+80-20%	S103Z96Z5UYAXST	DL 125-103 Z	–	–
150 pF	± 10%	S151K33Z5PYAWST	DL 125-151 K	S151K33Z5PQAWST	DL 250-151 K
150 pF	± 20%	S151M33Z5PYAWST	DL 125-151 M	S151M33Z5PQAWST	DL 250-151 M
1500 pF	± 20%	S152M52Z5UYAXST	DL 125-152 M	S152M52Z5UQAWST	DL 250-152 M
1500 pF	+80-20%	S152Z52Z5UYAXST	DL 125-152 Z	S152Z52Z5UQAWST	DL 250-152 Z
1800 pF	± 20%	S182M66Z5UYAXST	DL 125-182 M	S182M66Z5UQAWST	DL 250-182 M
1800 pF	+80-20%	S182Z66Z5UYAXST	DL 125-182 Z	S182Z66Z5UQAWST	DL 250-182 Z
220 pF	± 10%	S221K43Z5PYAWST	DL 125-221 K	S221K43Z5PQAWST	DL 250-221 K
220 pF	± 20%	S221M43Z5PYAWST	DL 125-221 M	S221M43Z5PQAWST	DL 250-221 M
2200 pF	± 20%	S222M66Z5UYAXST	DL 125-222 M	S222M66Z5UQAWST	DL 250-222 M
2200 pF	+80-20%	S222Z66Z5UYAXST	DL 125-222 Z	S222Z66Z5UQAWST	DL 250-222 Z
330 pF	± 10%	S331K43Z5PYAWST	DL 125-331 K	S331K43Z5PQAWST	DL 250-331 K
330 pF	± 20%	S331M43Z5PYAWST	DL 125-331 M	S331M43Z5PQAWST	DL 250-331 M
3300 pF	± 20%	S332M76Z5UYAXST	DL 125-332 M	S332M76Z5UQAWST	DL 250-332 M
3300 pF	+80-20%	S332Z76Z5UYAXST	DL 125-332 Z	S332Z76Z5UQAWST	DL 250-332 Z
470 pF	± 20%	S471M43Z5UYAWST	DL 125-471 M	S471M43Z5UQAWST	DL 250-471 M
470 pF	+80-20%	S471Z43Z5UYAWST	DL 125-471 Z	S471Z 43Z5UQAWST	DL 250-471 Z
4700 pF	± 20%	S472M76Z5UYAXST	DL 125-472 M	S472M76Z5UQAWST	DL 250-472 M
4700 pF	+80-20%	S472Z76Z5UYAXST	DL 125-472 Z	S472Z76 Z5UQAWST	DL 250-472 Z
5100 pF	± 20%	S512M76Z5UYAXST	DL 125-512 M	S512M76Z5UQAWST	DL 250-512 M
5100 pF	+80-20%	S512Z76Z5UYAXST	DL 125-512 Z	S512Z76Z5UQAWST	DL 250-512 Z
560 pF	± 20%	S561M43Z5UYAWST	DL 125-561 M	S561M43Z5UQAWST	DL 250-561 M
560 pF	+80-20%	S561Z43Z5UYAWST	DL 125-561 Z	S561Z43Z5UQAWST	DL 250-561 Z
680 pF	± 20%	S681M43Z5UYAWST	DL 125-681 M	S681M43Z5UQAWST	DL 250-681 M
680 pF	+80-20%	S681Z43Z5UYAWST	DL 125-681 Z	S681Z43Z5UQAWST	DL 250-681 Z
6800 pF	± 20%	S682M79Z5UYAXST	DL 125-682 M	–	–
6800 pF	+80-20%	S682Z79Z5UYAXST	DL 125-682 Z	–	–
8200 pF	± 20%	S822M86Z5UYAXST	DL 125-822 M	–	–
8200 pF	+80-20%	S822Z86Z5UYAXST	DL 125-822 Z	–	–

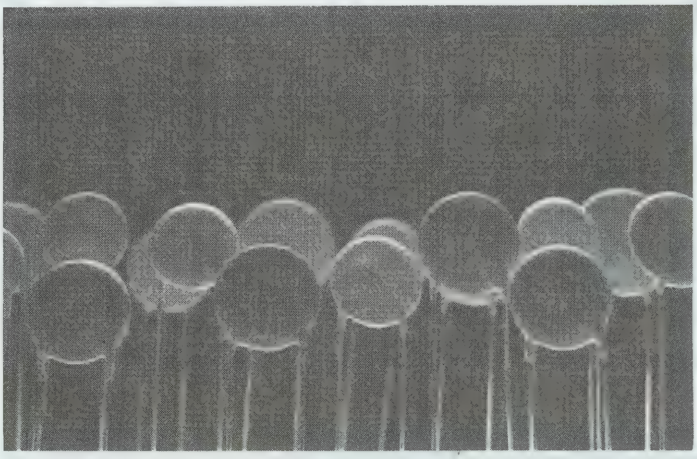
*Other parts available—contact factory representative.
NOTE: These capacitors should be used per the appropriate UL, CSA or VDE standard. Those standards may differ in test methods.

SERIES U

Ultra-Kap® 3VDC through 100VDC, Low Voltage EIA Class IV

2

Ceramic Capacitors



DESCRIPTION:

Philips Components Ultra-Kap® capacitors provide many advantages when compared to ordinary ceramic capacitors. Their unique semi-conductor design allows for the maximum in capacitance while retaining the miniature size required for today's ever decreasing printed circuit board sizes.

Three types of Ultra-Kap®'s are being offered

1. 3V:
   These units have the highest capacitance density of all disc capacitors; the Standard Tolerance is GMV (+100/−0%); Std TC is Y5T.
2. Ultra-Kap® I:
   This is the most commonly used Class IV capacitor; Standard Tolerance is +/−20%, units are also available with +80/−20% tolerance.
3. Ultra-Kap® II:
   These units, available with both +/−20% and +80/−20% tolerance and with Standard TC of Y5T, have the advantage of being able to withstand, for up to 5 seconds, a DC Voltage as high as twice their rated Voltage. They are also available with voltage ratings as high as 100VDC and typically they are one Standard Size SMALLER than an equivalent UKI for a given voltage and Capacitance combination.

ELECTRICAL PARAMETERS:

CAPACITANCE:
Measured @ 1KHz @ 0.1VRMS max. @ 25°C.

DISSIPATION FACTOR:
Measured @ 1KHz @ 0.1VRMS Max. @ 25°C.

DIELECTRIC STRENGTH:
Ultra-Kap® I: Rated Voltage
Ultra-Kap® II: 200% of Rated Voltage

INSULATION RESISTANCE:
Per EIA RS-198C; IR is specified as MegOhm MicroFarad Product by Voltage:
3V Rated Parts: .004 M $\Omega\,\mu$F
12V Rated Parts: .04 M $\Omega\,\mu$F
16V Rated Parts: .10 M $\Omega\,\mu$F
25V Rated Parts: 1.0 M $\Omega\,\mu$F
50, 75 and 100V Rated Parts: 10.0 M $\Omega\,\mu$F
Refer to Standard Stock Listing.
For Standard Stock Part IR ratings, see Listing

ENCAPSULATION:
Phenolic Resin, Green colored.

OPERATING TEMPERATURE RANGE:
−55°C to +125°C for 12, 16, 25, 50, 75 an 100V Rating,
−55°C to +85°C for 3V Rating.

MARKING:
Philips Components Logo (Diamond Shape), Cap citance Value (in Micro-Farad or Pico-Farad), E Capacitance Tolerance Code, Rated Voltage (f Voltage ratings other than 500/600VDC), E Temperature Characteristic (In this order, as si permits);

2

Ceramic Capacitors

PACKAGING:

Both Bulk and Radial Tape and Reel (per EIA RS-468) product is available. Taped and Reeled product available on 2000 pcs. Reels only.

LEADFORMS:

Bulk Product available in variety of Forms, Spacings, Lengths and Wire Diameters. Taped and Reeled Product available with 5MM (.197″) Nominal Spacing, #24AWG CCS Wire, IKC (Standard), SOL or SLC Leads.

ULTRA-KAP® RANGE CHARTS

Size and Electrical Code

Type of UK		3V	UKI	UKII	UKI	UKII	UKI	UKII	UKI	UKII	UKII
Voltage		3	12	12	16	16	25	25	50	50	75
Voltage Code		A	B	B	C	C	E	E	F	F	G
Maximum DF		**10%**	**7%**	**7%**	**5%**	**5%**	**5%**	**5%**	**5%**	**5%**	**5%**
EIA CAPACITANCE CODE	103		20KM	20KH	20KW	20KW	20KW	20NW	27LJ	20LJ	27LJ
	153		27KH	27KH	27KH	27KU	27KU	27NU	40LJ	27LJ	40LJ
	183		27KH	27KG	27KG	27KU	27KU	27NU	40LJ	27LJ	40LJ
	223		27KG	27KF	27KF	27KU	27KU	27NU	47LJ	27LJ	47LJ
	333		27KF	27KC	27KE	27KU	40KR	27NU	47LJ	40LJ	47LJ
	473		27KC	27JY	40KE	40KY	40KP	40NY	59LJ	40LJ	59LJ
	503		27JY	27JY	40KE	40KY	40KP	40NY	59LJ	40LJ	59LJ
	683		40KC	27KC	40KD	40KY	47KN	40NY	69LJ	47LJ	69LJ
	104	20TK	40JY	40KC	47KC	40KY	59KM	40NY	82LJ	59LJ	69LJ
	154	29TH	47JY	47KC	59KA	47KM	69KJ	47NM		69LJ	
	224	29TH	59JX	59JX	69JX	59KM	82KG	59NM		82LJ	
	334	40TG	69JW	69JW	82JW	82KM		82NM			
	474	40TF	82JW	82JW							
	684	59TE									
	105	59TD									
	225	82TB									

Note: 1 Inch = 25.4 mm

The last two digits in this chart represent the electrical detail code, needed for P/N assignment; while the first two digits are the size code:

Size Dia.
20 = .197″ dia.
27 = .290″ dia.
39 = .394″ dia.
40 = .400″ dia.
47 = .472″ dia.
59 = .590″ dia.
69 = .690″ dia.
82 = .820″ dia.

Available Temperature Characteristics by Type of UK MTL.

EIA TC Code	Material
X5R	UKI
X5S	UKI
X5T	UKI
X5U	UKI,UKII
X5V	UKI,UKII
X7S	UKI
X7T	UKI
X7U	UKI,UKII
X7V	UKI,UKII

EIA TC Code	Material
Y5P	UKI
Y5R	UKI
Y5S	UKI
Y5T	UKI,UKII,3V
Y5U	UKI,UKII
Y5V	UKI,UKII

EIA TC Code	Material
Z5P	UKI
Z5R	UKI
Z5S	UKI
Z5T	UKI,UKII
Z5U	UKI,UKII
Z5V	UKI,UKII

CERAMIC CAPACITOR PART NUMBER SYSTEM

ULTRA-KAP® Disc Capacitors

U 104 M 40 Y5P B TH JY

U Ultra-Kap Capacitors

CAPACITANCE VALUE
First two digits are significant, third digit is a multiplier as follows:

Digit	Multiplier
2	x100
3	x1000
4	x10000
5	x100000

Example: 104=10x10000=100000pF

Tolerance Code:
M ±20%
P +100/-0% (GMV)
Z +80/-20%

20	.197"Dia x.156"Thick
29	.290"Dia x.156"Thick
39	.394"Dia x.156"Thick
40	.400"Dia x.156"Thick
47	.472"Dia x.156"Thick
59	.590"Dia x.156"Thick
69	.690"Dia x.156"Thick
82	.820"Dia x.156"Thick
92	.920"Dia x.156"Thick

Note: 1 inch = 25.4mm

Temperature Characteristic per EIA RS-198

First Digit is Lower Temperature	Second Digit is Highest Temperature	Third Digit is Percent Change Allowed
X -55°C	4 +65°C	P ±10%
Y -30°C	5 +85°C	R ±15%
Z +10°C	6 +105°C	S ±22%
	7 +125°C	T +22/-33%
	8 +150°C	U +22/-56%
		V +22/-82%

Changes in Capacitance are all using the 25°C Cap. Value as reference Point.

A	3VDC
B	12VDC
C	16VDC
E	25VDC
F	50VDC
G	75VDC
H	100VDC

Code	Space	Length	Wire Dia.	Form	Pack
AA	.250"	1.0"Min	#22	SLL	Bulk
AB	.375"	1.0" Min	#22	SLL	Bulk
BE	.250"	.187"	#22	SLC	Bulk
BF	.375"	.187"	#22	SLC	Bulk
CE	.250"	.187"	#22	BBC	Bulk
CF	.375"	.187"	#22	BBC	Bulk
FE	.250"	.187"	#22	IKC	Bulk
FF	.375"	.187"	#22	IKC	Bulk
GE	.250"	.187"	#22	OKC	Bulk
GF	.375"	.187"	#22	OKC	Bulk
GS	.250"	.146"	#22	SOL	Bulk
GT	.375"	.146"	#22	SOL	Bulk
GU	.200"	.146"	#22	SOL	Bulk
HC	.250"	.180"	#20	SSK	Bulk
HD	.375"	.180"	#20	SSK	Bulk
HF	.300"	.180"	#20	SSK	Bulk
MA	.200"	1.00"Min	#22	SLL	Bulk
MB	.200"	1.00"Min	#24	SLL	Bulk
TE	.250"	Ho-18MM	#24	SLC	Tape&Reel
TF	.250"	Ho-16MM	#24	IKC	Tape&Reel
TH	.200"	Ho-16MM	#24	IKC	Tape&Reel
TK	.200"	Ho-16MM	#24	SOL	Tape&Reel
TM	.200"	Ho-18MM	#24	SLC	Tape&Reel

Note: Above Numbering System is for STANDARD PRODUCT.

Code	IR in Meg Ω's
JA	.001
JB	.002
JG	.01
JH	.02
JL	.05
JN	.1
JT	.2
JU	.25
JW	.3
JX	.4
JY	.5
KC	1
KD	1.5
KE	2
KF	3
KG	4
KH	5
KM	10
KN	15
KP	20
KR	30
KU	50
KW	65
KX	80
KY	100
LF	500
LJ	1000

Ultra-Kap® 3VDC through 100VDC, Low Voltage EIA Class IV

STANDARD STOCK LISTING

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	MAX. DIA.	MAX. THICK.	LEAD SPACE	LEAD STYLE	MIN. I.R. MEG OHMS	MAX. D.F.
Ultra-Kap 3 Volt DCW Y5T									
.1 mf	U104P20Y5TAAATK	UK104	GMV	.20"	.190"	.250"	SLL	.04	10%
.22 mf	U224P40Y5TAAATH	UK224	GMV	.40"	.190"	.250"	SLL	.02	10%
.47 mf	U474P40Y5TAAATF	UK474	GMV	.40"	.190"	.250"	SLL	.008	10%
1.0 mf	U105P59Y5TAABTD	UK105	GMV	.59"	.156"	.375"	SLL	.004	10%
2.2 mf	U225P82Y5TAABTB	UK225	GMV	.82"	.156"	.375"	SLL	.002	10%
12 Volt DCW Y5S									
.05 µf	U503M29Y5SBAAJY	UK12503	±20%	.29"	.156"	.250"	SLL	0.5	7%
.05 µf	U503M29Y5SBTHKC	–	±20%	.29"	.140"	.200"	IKC*	0.5	7%
.05 µf	U503M29Y5SBBEJY	XXUK12503	±20%	.29"	.156"	.250"	SLC	0.5	7%
.05 µf	U503Z29Y5SBAAJY	UK10-503	+80-20%	.29"	.156"	.250"	SLL	0.5	7%
.1 µf	U104M40Y5SBAAJY	UK12104	±20%	.40"	.156"	.250"	SLL	0.5	7%
.1 µf	U104M40Y5SBTHJY	–	±20%	.40"	.140"	.200"	IKC*	0.5	7%
.1 µf	U104M40Y5SBBEJY	XXUK12104	±20%	.40"	.156"	.250"	SLC	0.5	7%
.1 µf	U104Z40Y5SBAAJY	UK10-104	+80-20%	.40"	.156"	.250"	SLL	0.5	7%
.2 µf	U204M59Y5SBABJX	UK12204	±20%	.59"	.156"	.375"	SLL	0.4	7%
.2 µf	U204Z59Y5SBABJX	–	+80-20%	.59"	.156"	.375"	SLL	0.4	7%
.47 µf	U474M82Y5SBABJT	UK12474	±20%	.82"	.156"	.375"	SLL	0.2	7%
.47 µf	U474M82Y5SBBFJT	XXUK12474	±20%	.82"	.156"	.375"	SLC	0.2	7%
.47 µf	U474Z82Y5SBABJT	–	+80-20%	.82"	.156"	.375"	SLL	0.2	7%
16 Volt DCW Y5S									
.01 µf	U103M20Y5SCAAKH	UK16103	±20%	.20"	.156"	.250"	SLL	5.0	5%
.01 µf	U103M20Y5SCBEKH	XXUK16103	±20%	.20"	.156"	.250"	SLC	5.0	5%
.022 µf	U223M29Y5SCAAKF	UK16223	±20%	.29"	.156"	.250"	SLL	3.0	5%
.022 µf	U223M29Y5SCBEKF	XXUK16223	±20%	.29"	.156"	.250"	SLC	3.0	5%
.033 µf	U333M29Y5SCAAKF	UK16333	±20%	.29"	.156"	.250"	SLL	3.0	5%
.033 µf	U333M29Y5SCBEKF	XXUK16333	±20%	.29"	.156"	.250"	SLC	3.0	5%
.05 µf	U503M39Y5SCAAKE	UK16503	±20%	.39"	.156"	.250"	SLL	2.0	5%
.05 µf	U503M39Y5SCBEKE	XXUK16503	±20%	.39"	.156"	.250"	SLC	2.0	5%
.068 µf	U683M40Y5SCAAKD	UK16683	±20%	.40"	.156"	.250"	SLL	1.5	5%
.1 µf	U104M47Y5SCABKC	UK16104	±20%	.47"	.156"	.375"	SLL	1.0	5%
.1 µf	U104M47Y5SCBFKC	XXUK16104	±20%	.47"	.156"	.375"	SLC	1.0	5%
.15 µf	U154M59Y5SCABKA	UK16154	±20%	.59"	.156"	.375"	SLL	.6	5%
.15 µf	U154M59Y5SCBFKA	XXUK16154	±20%	.59"	.156"	.375"	SLC	.6	5%
.2 µf	U204M69Y5SCABJX	UK16204	±20%	.69"	.156"	.375"	SLL	.4	5%
.2 µf	U204M69Y5SCBFJX	XXUK16204	±20%	.69"	.156"	.375"	SLC	.4	5%
.3 µf	U304M82Y5SCBFJW	UK16304	±20%	.82"	.156"	.375"	SLL	.3	5%
.3 µf	U304M82Y5SCABJW	XXUK16304	±20%	.82"	.156"	.375"	SLC	.3	5%
25 Volt DCW Y5S									
.01 µf	U103M20Y5PEAAKW	UK25103	±20%	.20"	.156"	.250"	SLL	65	5%
.01 µf	U103M20Y5PETHKW	–	±20%	.20"	.140"	.200"	IKC*	65	5%
.01 µf	U103M20Y5PEBEKW	XXUK25103	±20%	.20"	.156"	.250"	SLC	65	5%
.022 µf	U333M40Y5PEAAKR	UK25223	±20%	.29"	.156"	.250"	SLL	45	5%
.022 µf	U223M29Y5PEBEKF	XXUK25223	±20%	.29"	.156"	.250"	SLC	45	5%
.033 µf	U503M40Y5PEAAKP	UK25333	±20%	.40"	.156"	.250"	SLL	30	5%
.033 µf	U333M40Y5PEBEKR	XXUK25333	±20%	.40"	.156"	.250"	SLC	30	5%
.05 µf	U223M29Y5PEAAKU	UK25503	±20%	.40"	.156"	.250"	SLL	20	5%
.05 µf	U503M40Y5PETHKP	–	±20%	.40"	.140"	.200"	IKC*	20	5%

SERIES U

Ultra-Kap,® 3VDC through 100VDC, Low Voltage EIA Class IV

STANDARD STOCK LISTING

2

Ceramic Capacitors

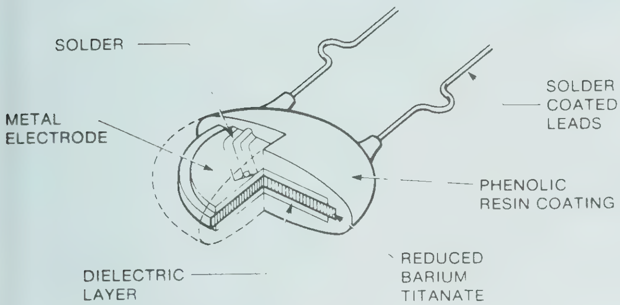
CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	MAX. DIA.	MAX. THICK.	LEAD SPACE	LEAD STYLE	MIN. I.R. REG OHMS	MAX. D.F.
.05 µf	U503M40Y5PEBEKP	XXUK25503	±20%	.40″	.156″	.250″	SLC	20	5%
.05 µf	U503Z40Y5PEAAKP	—	+80-20%	.40″	.156″	.250″	SLL	20	5%
.068 µf	U683M47Y5PEAAKN	UK25683	±20%	.47″	.156″	.250″	SLL	15	5%
.068 µf	U683M47Y5PEBEKN	XXUK25683	±20%	.47″	.156″	.250″	SLC	15	5%
.1 µf	U104M59Y5PEABKM	UK25104	±20%	.59″	.156″	.375″	SLL	10	5%
.1 µf	U104M59Y5PEBFKM	XXUK25104	±20%	.59″	.156″	.375″	SLC	10	5%
.1 µf	U104Z59Y5PEABKM	—	+80-20%	.59″	.156″	.375″	SLL	10	5%
.15 µf	U154M69Y5PEABKJ	UK25154	±20%	.69″	.156″	.375″	SLL	6	5%
.15 µf	U154M69Y5PEBFKJ	XXUK25154	±20%	.69″	.156″	.375″	SLC	6	5%
.2 µf	U204M82Y5PEABKG	UK25204	±20%	.82″	.156″	.375″	SLL	4	5%
.2 µf	U204Z82Y5PEABKG	—	+80-20%	.82″	.156″	.375″	SLL	4	5%
50 Volt DCW Y5P									
.01 µf	U103M29Y5PFAALJ	UK50103	±20%	.29″	.156″	.250″	SLL	1000	5%
.01 µf	U103M29Y5PFTHLJ	—	±20%	.29″	.140″	.200″	IKC*	1000	5%
.01 µf	U103M29Y5PFBELJ	XXUK50103	±20%	.29″	.156″	.250″	SLC	1000	5%
.015 µf	U153M40Y5PFAALJ	UK50153	±20%	.40″	.156″	.250″	SLL	1000	5%
.015 µf	U153M40Y5PFBELJ	XXUK50153	±20%	.40″	.156″	.250″	SLC	1000	5%
.022 µf	U223M47Y5PFAALJ	UK50223	±20%	.47″	.156″	.250″	SLL	1000	5%
.022 µf	U223M47Y5PFBELJ	XXUK50223	±20%	.47″	.156″	.250″	SLC	1000	5%
.033 µf	U333M47Y5PFABLJ	UK50333	±20%	.47″	.156″	.375″	SLL	1000	5%
.033 µf	U333M47Y5PFBFLJ	XXUK50333	±20%	.47″	.156″	.375″	SLC	1000	5%
.047 µf	U473M59Y5PFABLJ	UK50473	±20%	.59″	.156″	.375″	SLL	1000	5%
.047 µf	U473M59Y5PFBFLJ	XXUK50473	±20%	.59″	.156″	.375″	SLC	1000	5%
.05 µf	U503M59Y5PFABLJ	UK50503	±20%	.59″	.156″	.375″	SLL	1000	5%
.05 µf	U503M59Y5PFBFLJ	XXUK50503	±20%	.59″	.156″	.375″	SLC	1000	5%
.068 µf	U683M69Y5PFABLJ	UK50683	±20%	.69″	.156″	.375″	SLL	1000	5%
.068 µf	U683M69Y5PFBFLJ	XXUK50683	±20%	.69″	.156″	.375″	SLC	1000	5%
.1 µf	U104M82Y5PFABLJ	UK50104	±20%	.82″	.156″	.375″	SLL	1000	5%
.1 µf	U104M82Y5PFBFLJ	XXUK50104	±20%	.82″	.156″	.375″	SLC	1000	5%
Ultra-Kap II 75 Volt DCW Y5U									
.01 µf	U103Z29Y5UGAAPK	UKZ75103	+80-20%	.29″	.156″	.250″	SLL	5000	5%
.018 µf	U183Z40Y5UGAAPK	UKZ75183	+80-20%	.40″	.156″	.250″	SLL	5000	5%
.022 µf	U223Z47Y5UGAAPK	UKZ75223	+80-20%	.47″	.156″	.250″	SLL	5000	5%
.033 µf	U333Z59Y5UGABPK	UKZ75333	+80-20%	.59″	.156″	.375″	SLL	5000	5%
.1 µf	U104Z69Y5UGABPK	UKZ75104	+80-20%	.69″	.156″	.375″	SLL	5000	5%
100 Volt DCW Y5T									
.01 µf	U103M29Y5THMBLK	—	±20%	.29″	.156″	.197″	SLL	5000	5%

* Tape & Reel Packaging

Philips Components • 7158 Merchant Avenue • El Paso, TX 79915 • (915) 775-4242 • FAX: (915) 775-4249

Ultra-Kap,® 3VDC through 100VDC, Low Voltage EIA Class IV

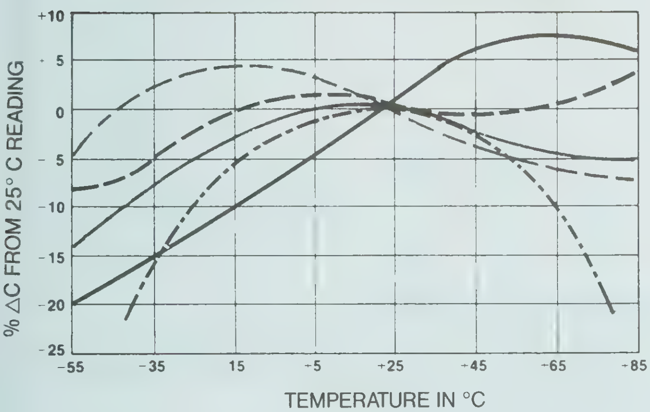
ULTRA-KAP® DISC CAPACITOR CHARACTERISTICS



Thin dielectric layers on a semiconducting ceramic base are formed in four steps; (1) Formulation of green ceramic body, (2) Firing the green ceramic in an oxidizing atmosphere to form a dielectric body, (3) Chemically reducing this body to produce semiconducting properties by heating in a reducing atmosphere, (4) Reoxidation of the ceramic surface to form a thin dielectric layer by firing in an oxidizing atmosphere.

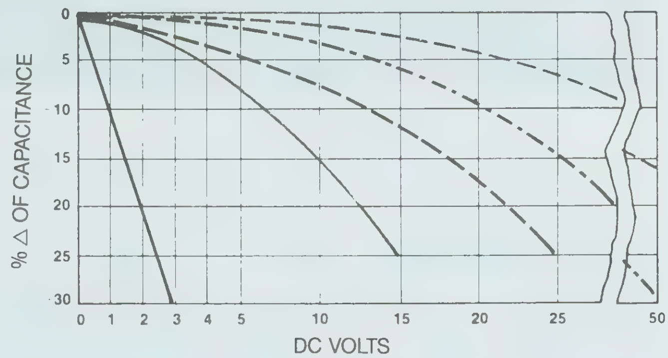
TYPICAL CHARACTERISTICS

CAPACITANCE VS TEMPERATURE



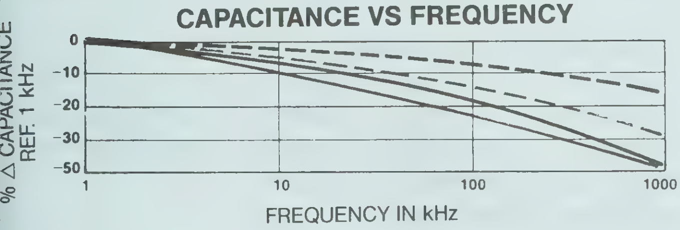
Ultra-Kap I 3V
Ultra-Kap I 12V
Ultra-Kap I 16V & 25V
Ultra-Kap I 50V
Ultra-Kap II 12V, 50V & 75V

CAPACITANCE VS DC VOLTAGE



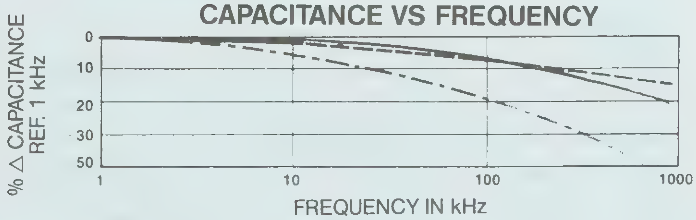
Ultra-Kap I 3V
Ultra-Kap I 12V
Ultra-Kap I 16V & 25V
Ultra-Kap I 50V
Ultra-Kap II 12V, 50V & 75V

CAPACITANCE VS FREQUENCY



Ultra-Kap I 3V
Ultra-Kap I 12V
Ultra-Kap I 16V & 25V
Ultra-Kap I 50V

CAPACITANCE VS FREQUENCY



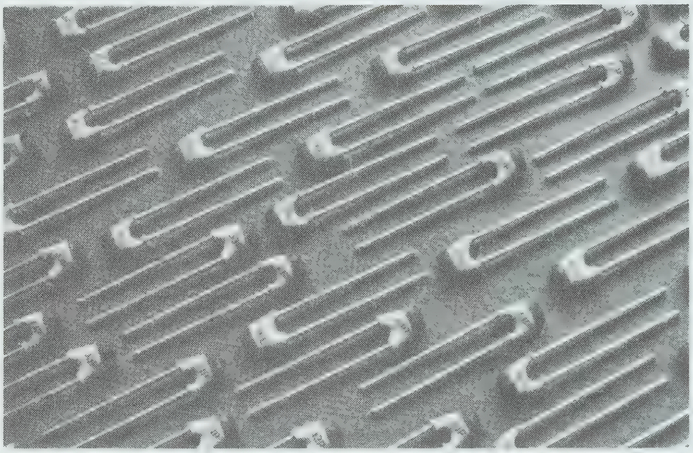
Ultra-Kap II 12V
Ultra-Kap II 50V
Ultra-Kap II 75V

SERIES R

50VDC AND 100VDC, Temperature Compensating and General Purpose Ceramic Plate Capacitors

2

Ceramic Capacitors



DESCRIPTION:

Series R Single Plate Capacitors are radial leaded, conformal coated capacitors; they are similar to disc capacitors except for their rectangular shape and non-noble metal electrodes.

They may be used as direct replacements for disc or multi-layer capacitors of equivalent ratings.

Significant cost savings are possible, particularly for low cap value and/or tight tolerance applications.

ELECTRICAL SPECIFICATIONS:

CAPACITANCE:
.68pF to .022uF, per Range Chart; Standard Parts are shown in P/N Stock Listing.

CAPACITANCE TOLERANCE:
Depends both on Capacitance Value and Temp. Char., as shown below:
Value < 10pF: ± .25 pF, any TC
Value ≥ 10pF: ± 2% for TC's other than Y5P and Z5V.
Y5P TC: ± 10% for all values.
Z5V TC: +80/−20% for all values.

DISSIPATION FACTOR:
3.5% Maximum for Y5P and Z5V TC's.
.15% Maximum (C = greater than 50pF) or .15 [(15/C) + .7]% maximum
(C =< 50 pF) for all others.

STANDARD CAP. AND DF MEASUREMENT CONDITIONS:
Y5P and Z5V: Measure @ 1 ±.1 KHz, 1 ±.1VRMS, @ (or referred to) 20°C.
All Others: Measure @ 1 ± .1 MHz, @ 1.2 VRMS Max, @ (or referred to) 20°C.

CAPACITANCE MARKING:
Marked in pF for units below 100 pF, with "p" denoting the decimal position; for units 100 pF and above, the NANO Farad is used, with "n" denoting the decimal position.

WORKING VOLTAGE:
Z5V: 50VDC
All Others: 100VDC (500 VDC also available)

DIELECTRIC STRENGTH:
250% of Rated Working Voltage.

CERAMIC CAPACITOR PART NUMBER SYSTEM
SINGLE PLATE CAPACITORS

R 101 G 33 C0G H WG AP

R Plate Capacitors

CAPACITANCE VALUE
First two digits are significant, third digit is a multiplier as follows:

0 x1	
1 x10	Example:
2 x100	101=10x10=
3 x1000	100pF
9 x.1	569 = 56 x .1 = 5.6pF

Tolerance Code:
C ±.25pF (<10pF)
G ±2% (Class I≥10pF)
K ±10% (Class II, Y5P)
Z +80/-20% (Class III, Z5V)

Size	Width	Height
13	.142″ Max	.248″ Max
23	.177″ Max	.288″ Max
33	.201″ Max	.311″ Max
43	.244″ Max	.354″ Max
53	.244″ Max	.441″ Max

F 50VDC
Class III, Z5V

H 100VDC
All Others

AP Class I Part
SP Class II or III

Code	Space	Length	Form	Packing
WC	.100″	.500″Min	Flange	Bulk 1K Pcs
WD	.200″	.157±.020″	Flange	Bulk 1K Pcs
WE	.100″	.157±.020″	Flange	Bulk 1K Pcs
WF	.200″	.500″Min	Flange	Bulk 1K Pcs
WG	.200″	Ho-18MM	Flange	Tape&Reel 4K
WH	.100″	Ho-18MM	Flange	Tape&Reel 4K

All with .023″ (.6MM) Dia Tinned Copper Leads

Note: 1 Inch = 25.4 mm

Code	Temperature Characteristic	EIA Class	Colorband Marking
M7J	P100+120/-40PPM	I	Red/Violet
C0G	NPO±30PPM	I	Black
U1G	N075±30PPM	I	Red
P2G	N150±40PPM	I	Orange
R2H	N220±40PPM	I	Yellow
S2H	N330±60PPM	I	Green
T2J	N470±60PPM	I	Blue
U2J	N750±120PPM	I	Violet
P3K	N1500+500/-0PPM	I	Orange/Orange
Y5P	±10%△C -30°C to +85°C	II	Yellow
Z5V	+22/-82%△C +10 to +85°C	III	Green

SERIES R

50VDC AND 100VDC, Temperature Compensating and General Purpose Ceramic Plate Capacitors

2

Ceramic Capacitors

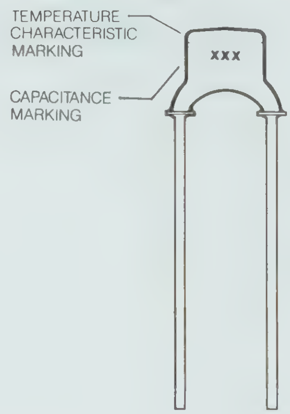
INSULATION RESISTANCE:

Measured @ Rated Voltage @ 25°C.
Y5P and Z5V: 1000MegΩ Minimum
All Others: 1000MegΩ Minimum

OPERATING TEMPERATURE RANGE:

−55°C to +85°C.
50% Voltage De-Rating @ 125°C.
90% Insulation Resistance De-Rating @ 125°C.

EIA Code	Temperature Characteristics (C= 〉22pf)	Color Code
M7J	P100 + 120/-40PPM	Red / Violet
C0G	NPO ± 30PPM	Black
U1G	N075 ± 30PPM	Red
P2G	N150 ± 40PPM	Orange
R2H	N220 ± 40PPM	Yellow
S2H	N330 ± 60PPM	Green
T2J	N470 ± 60PPM	Blue
U2J	N750 ± 120PPM	Violet
P3K	N1500 + 500/-0PPM	Orange/Orange
Y5P	±10% △C from -30°C to +85°C	Yellow
Z5V	+22/-82% △C from +10 to 85°C	Green



SEE RANGE CHART FOR CAPACITANCE MARKING CODES

Note: 1 Inch = 25.4 mm

SIZE CHART: MILLIMETERS

Size Code	W (Max.)	H (Max.)
13	3.6	6.3
23	4.5	7.3
33	5.1	7.9
43	6.2	9.0
53	6.2	11.2

SIZE CHART: INCHES

Size Code	W (Max.)	H (Max.)
13	.142	.248
23	.177	.288
33	.201	.311
43	.244	.354
53	.244	.441

SINGLE PLATE CAPACITORS: (Other Parts Available–See Range Chart)

CAP.	NEW PART NUMBER	CAP. TOL.	VDCW	SIZE CODE	LEAD SPACING	PACK'G	LEAD LENGTH
1.0 pF	R109C13M7JHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
1.5 pF	R159C13M7JHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
2.2 pF	R229C13C0GHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
2.7 pF	R279C13C0GHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
2.7 pF	R279C13C0GHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
3.3 pF	R339C13M7JHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
3.9 pF	R399C13C0GHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
3.9 pF	R399C13U2JHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
4.7 pF	R479C13C0GHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
4.7 pF	R479C13U2JHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
5.6 pF	R569C13C0GHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
5.6 pF	R569C13U2JHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
6.8 pF	R689C13C0GHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
6.8 pF	R689C13U2JHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
8.2 pF	R829C13C0GHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN
8.2 pF	R829C13U2JHWCAP	+−.25pf	100	13	.100″	BULK	.50″ MIN

Philips Components • 7158 Merchant Avenue • El Paso, TX 79915 • (915) 775-4242 • FAX: (915) 775-4249

SERIES R

50VDC AND 100VDC, Temperature Compensating and General Purpose Ceramic Plate Capacitors

2

Ceramic Capacitors

SINGLE PLATE CAPACITORS: (Other Parts Available—See Range Chart)

CAP.	NEW PART NUMBER	CAP. TOL.	VDCW	SIZE CODE	LEAD SPACING	PACK'G	LEAD LENGTH
10 pF	R100G13C0GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
10 pF	R100G13C0GHWFAP	+−2%	100	13	.100″	BULK	.50″ MIN
10 pF	R100G13P2GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
10 pF	R100G13U2JHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
12 pF	R120G13C0GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
12 pF	R120G13C0GHWFAP	+−2%	100	13	.100″	BULK	.50″ MIN
12 pF	R120G13P2GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
12 pF	R120G13CU2JWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
15 pF	R150G13C0GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
15 pF	R150G13C0GHWFAP	+−2%	100	13	.100″	BULK	.50″ MIN
15 pF	R150G13P2GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
15 pF	R150G13U2JHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
18 pF	R180G13C0GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
18 pF	R180G13C0GHWFAP	+−2%	100	13	.100″	BULK	.50″ MIN
18 pF	R180G13P2GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
18 pF	R180G13U2JHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
22 pF	R220G13C0GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
22 pF	R220G13C0GHWFAP	+−2%	100	13	.100″	BULK	.50″ MIN
22 pF	R220G13P2GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
22 pF	R220G13U2JHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
27 pF	R270G13C0GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
27 pF	R270G13C0GHWFAP	+−2%	100	13	.100″	BULK	.50″ MIN
27 pF	R270G13P2GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
27 pF	R270G13U2JHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
33 pF	R330G13C0GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
33 pF	R330G13C0GHWFAP	+−2%	100	13	.100″	BULK	.50″ MIN
33 pF	R330G13P2GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
33 pF	R330G13U2JHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
39 pF	R390G23C0GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
39 pF	R390G23C0GHWFAP	+−2%	100	13	.100″	BULK	.50″ MIN
39 pF	R390G23P2GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
39 pF	R390G13U2JHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
47 pF	R470G33C0GHWFAP	+−2%	100	13	.100″	BULK	.50″ MIN
47 pF	R470G23P2GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
47 pF	R470G13U2JHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
56 pF	R560G33C0GHWFAP	+−2%	100	13	.100″	BULK	.50″ MIN
56 pF	R560G33P2GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
56 pF	R560G23U2JHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
68 pF	R680G23C0GHWFAP	+−2%	100	13	.100″	BULK	.50″ MIN
68 pF	R680G33P2GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
68 pF	R680G23U2JHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
82 pF	R820G23C0GHWFAP	+−2%	100	13	.100″	BULK	.50″ MIN
82 pF	R820G43P2GHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
82 pF	R820G23U2JHWCAP	+−2%	100	13	.100″	BULK	.50″ MIN
100 pF	R101G33C0GHWFAP	+−2%	100	13	.100″	BULK	.50″ MIN

SERIES R

50VDC AND 100VDC, Temperature Compensating and General Purpose Ceramic Plate Capacitors

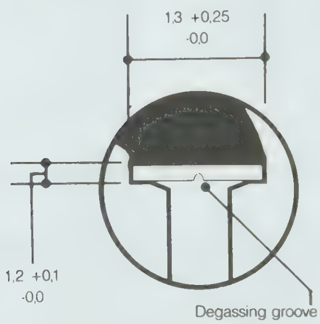
2

Ceramic Capacitors

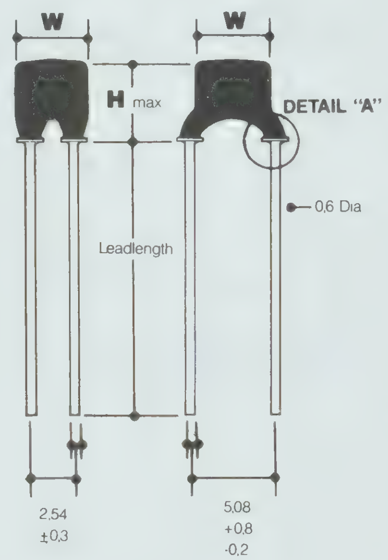
CAP.	NEW PART NUMBER	CAP. TOL.	VDCW VDCW	SIZE CODE	LEAD SPACING	PACK'G	LEAD LENGTH
100 pF	R101G33P2GHWCAP	+−2%	100	33	.100″	BULK	.50″ MIN
100 pF	R101G23P3KHWCAP	+−2%	100	23	.100″	BULK	.50″ MIN
100 pF	R101G23U2JHWCAP	+−2%	100	23	.100″	BULK	.50″ MIN
120 pF	R121G23P3KHWCAP	+−2%	100	23	.100″	BULK	.50″ MIN
150 pF	R151G23P3KHWCAP	+−2%	100	23	.100″	BULK	.50″ MIN
180 pF	R181G23P3KHWCAP	+−2%	100	23	.100″	BULK	.50″ MIN
220 pF	R221G33P3KHWCAP	+−2%	100	33	.100″	BULK	.50″ MIN
270 pF	R271G33P3KHWCAP	+−2%	100	33	.100″	BULK	.50″ MIN
330 pF	R331G43P3KHWCAP	+−2%	100	43	.100″	BULK	.50″ MIN
390 pF	R391G43P3KHWCAP	+−2%	100	43	.100″	BULK	.50″ MIN
470 pF	R471G53P3KHWCAP	+−2%	100	53	.100″	BULK	.50″ MIN
560 pF	R561G53P3KHWCAP	+−2%	100	53	.100″	BULK	.50″ MIN
.001 uF	R102K23Y5PHWFSP	+−10%	100	23	.200″	BULK	.50″ MIN
.001 uF	R102K23Y5PHWGSP	+−10%	100	23	.200″	T&R	.50″ REF
.01 uF	R103Z23Z5VFWFSP	80/20%	50	23	.200″	BULK	.50″ MIN
.01 pF	R103Z23Z5VFWGSP	80/20%	50	23	.200″	T&R	.50″ REF

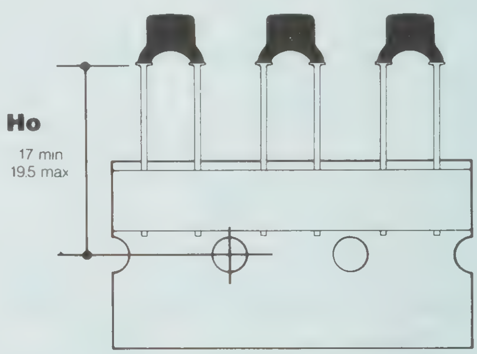
Mechanical Specifications.

(ALL DIMENSIONS IN MILLIMETERS)



DETAIL "A"





TAPE AND REEL DETAIL "B"

Pitch for both 2,54 and 5,08 leadspacing is 12,7MM (.5
Quantity per reel is 4000 Pcs.

MECHANICAL P/N CODES

PRODUCT FORM	LEAD SPACING	LEAD LENGTH	P/N CODE
BULK	2,54	13MIN	WC
BULK	5,08	4±0,5	WD
BULK	2,54	4±0,5	WE
BULK	5,08	13MIN	WF
T&R	2,54	N/A	WH
T&R	5,08	N/A	WG

Extended Conversion Factors

One Inch = 25.4001 mm
One mm = .03937 Inch

50VDC AND 100VDC, Temperature Compensating and General Purpose Ceramic Plate Capacitors

SINGLE PLATE CAPACITORS: RANGE CHART AND MARKING CODES

Designation (TC)		M7J	C0G	U1G	P2G	R2H	S2H	T2J	U2J	P3K	Y5P	Z5V
Voltage (DC) Rating		100V	100V	100V	100V	100V	100V	100V	100V	100V	50V	50V
Electrical Class Code		AP	AP	AP	AP	AP	AP	AP	AP	AP	SP	SP
Cap in pF	Marking	Size	Size	Size	Size	Size	Size	Size	Size	Size	Size	Size
1.0	1p0	13										
1.2	1p2	13										
1.5	1p5	13										
1.8	1p8	13	13									
2.2	2p2	13	13									
2.7	2p7	13	13									
3.3	3p3	13	13									
3.9	3p9	13	13	13	13	13			13			
4.7	4p7	13	13	13	13	13	13		13			
5.6	5p6	13	13	13	13	13	13		13			
6.8	6p8	13	13	13	13	13	13	13	13			
8.2	8p2	23	13	13	13	13	13	13	13			
10	10p	23	13	13	13	13	13	13	13			
12	12p	23	13	13	13	13	13	13	13			
15	15p	23	13	13	13	13	13	13	13			
18	18p	33	13	13	13	13	13	13	13	13		
22	22p	33	13	23	13	13	13	13	13	13		
27	27p		13	23	13	23	13	13	13	13		
33	33p		13	23	13	23	23	13	13	13		
39	39p		23	23	23	23	23	23	13	13		
47	47p		23	33	23	23	23	23	13	13		
56	56p		23	33	23	33	23	23	23	13		
68	68p		23	43	23	33	33	23	23	13		
82	82p		23	43	33	43	33	33	23	13		
100	n10		33	53	33	43	43	33	23	23		
120	n12		33	53	43	53	43	43	33	23		
150	n15				43	53	53	43	33	23		
180	n18						53	53	43	23	13	
220	n22							53	43	33	13	
270	n27								53	33	13	
330	n33								53	43	13	
390	n39									43	13	
470	n47									53	13	
560	n56									53	13	
680	n68										13	
820	n82										13	
1000	1n0										23	13
1200	1n2										23	
1500	1n5										23	
1800	1n8										23	
2200	2n2										33	13
2700	2n7										33	
3300	3n3										43	
3900	3n9										43	
4700	4n7										43	13
10000	10n											23
22000	22n											43

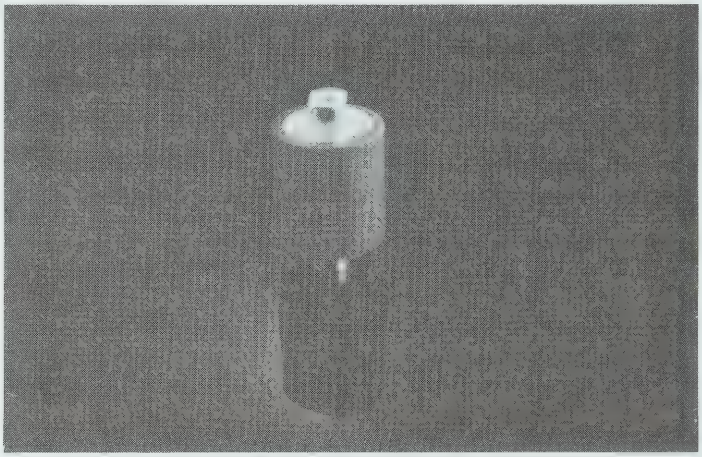
NOTE: 500 VDC available

SERIES T

5KVDC through 20KVDC RF RATED, Transmitting, Special Applications Ceramic Capacitors

2

Ceramic Capacitors



DESCRIPTION:

Philips Components RF Rated, ceramic transmitting capacitors are designed primarily for use in applications where very high RF currents, high KVA ratings and high working voltages exist. Special capacitor design reduces terminal self-inductance to permit higher frequency operation. A humidity resistant silicone coating and long flashover path assures safe, high voltage operation in free air. Units also feature stable temperature-capacitance characteristics and rugged mechanical construction for maximum reliability.

The 850-Series capacitors are extensively used in transmitters, antennas, induction heaters, X-ray, diathermy and electronic welding equipment.

SPECIFICATIONS

CAPACITANCE RANGE:
3pf to .001mf. Tested at 0.5 to 5.0 volts RMS, listed Test Freq. and +25°C.

CAPACITANCE TOLERANCE:
± 10% or ± 20% as listed.

WORKING VOLTAGE:
5,000, 7,500, 15,000 or 20,000 volts DC as listed.

DISSIPATION FACTOR (D.F.):
0.1% to 1.5% maximum as listed. Tested at 0.5 to 5.0 volts RMS, listed Test Freq. and +25°C.

DIELECTRIC STRENGTH:
150% of rated Working Voltage.

INSULATION RESISTANCE:
10,000 megohms minimum. Tested at 1000 volts DC maximum.

TEMPERATURE COEFFICIENT OR CHARACTERISTIC:
NP0, N750, N3300 or EIA code X5T, X5U as listed.

OPERATING TEMPERATURE RANGE:
−55°C to +85°C.

HUMIDITY PROTECTION:
Silicone coated. (850S, 857, 858S and 859S series)

LEADS:	**TERMINALS:**
Tinned Wire.	Silver Plated.

MARKING:
Philips Components Part Marking, catalog number, capacitance value, capacitance tolerance, working voltage and temperature coefficient or EIA temperature characteristic code.

PACKAGING:
Individually wrapped or bulk packaged, one per cavity in protective nest.

CAUTIONS IN HANDLING:
These capacitors are round and will roll off a table or desk if layed on their sides. Do not touch terminals of charged units.

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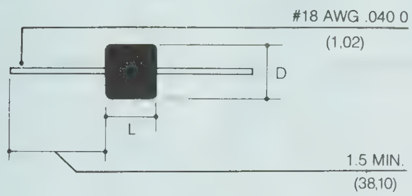
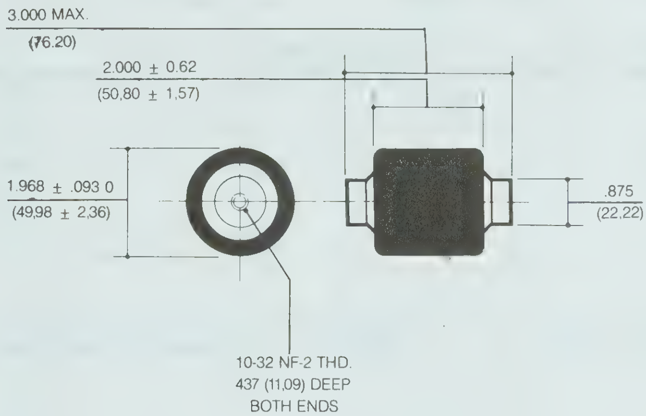
5KVDC through 20KVDC RF RATED, Transmitting, Special Applications Ceramic Capacitors

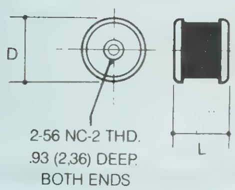
8530, 8540, 8550 — SERIES



859S — SERIES

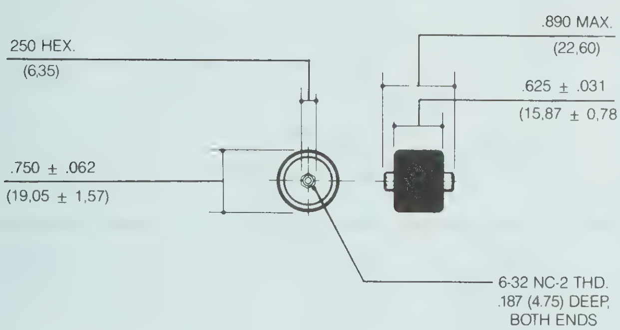


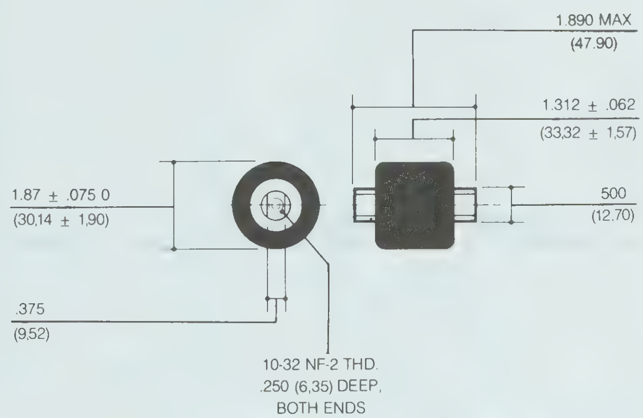
853A, 854A, 855A — SERIES



8570 — SERIES

850S, 858S — SERIES





	LENGTH		DIA.	
SERIES	in. ±.031	mm ±0.78	in. ±.031	mm ±0.78
853	.437	11.09	.500	12.70
854	.375	9.52	.375	9.52
855	.343	8.71	.250	6.35
853A	.484	12.29	.562	14.27
854A	.422	10.71	.437	11.09
855A	.390	9.90	.312	7.92

INCH **(MILLIMETER)**

INCH
(MILLIMETER)

Note: 1 Inch = 25.4 mm

SERIES T

5KVDC through 20KVDC RF RATED, Transmitting, Special Applications Ceramic Capacitors

STANDARD STOCK LISTING:

CAP.	NEW PART NUMBER	DIST. PART NUMBER	CAP. TOL.	VOLTAGE DCW PLUS HF PEAK	TEMP. COEF/ EIA CODE	MAX. D.F.	TEST FREQ.
8530, 8540, 8550—Series Wire Leads							
3 pf	T309K99C0GT8550	855-3Z	±10%	5,000	NPO	0.217%	1 MHz
5	T509K99C0GT8550	855-5Z	±10%	5,000	NPO	0.200%	1 MHz
10	T100K99U2JT8550	855-10N	±10%	5,000	N750	0.167%	1 MHz
10	T100K99C0GT8540	854-10Z	±10%	5,000	NPO	0.167%	1 MHz
20	T200K99C0GT8530	853-20Z	±10%	5,000	NPO	0.120%	1 MHz
40	T400K99U2JT8530	853-40N	±10%	5,000	N750	0.100%	1 MHz
853A, 854A, 855A—Series Threaded Terminals							
3 pf	T309K99C0GT855A	855A-3Z	±10%	5,000	NPO	0.217%	1 MHz
5	T509K99C0GT855A	855A-5Z	±10%	5,000	NPO	0.200%	1 MHz
10	T100K99C0GT854A	854A-10Z	±10%	5,000	NPO	0.167%	1 MHz
20	T200K99U2JT854A	854A-20N	±10%	5,000	N750	0.120%	1 MHz
40	T400K99U2JT853A	853A-40N	±10%	5,000	N750	0.100%	1 MHz
850S, 858S—Series Threaded Terminals							
25 pf	T250K99C0GV850S	850S-25Z	±10%	7,500	NPO	0.1%	1 MHz
50	T500K99C0GV850S	850S-50Z	±10%	7,500	NPO	0.1%	1 MHz
50	R500K99U2JV850S	850S-50N	±10%	7,500	N750	0.1%	1 MHz
75	T750K99U2JV850S	850S-75N	±10%	7,500	N750	0.1%	1 MHz
100	T101K99U2JT850S	850S-100N	±10%	5,000	N750	0.1%	1 MHz
500	T501M99X5TT858S	858S-500	±20%	5,000	X5T	1.5%	1 KHz
.001 mf	T102M99X5UT858S	858S-1000	±20%	5,000	X5U	1.5%	1 KHz
8570—Series Threaded Terminals							
25 pf	T250K99C0GW8570	857-25Z	±10%	15,000	NPO	0.1%	1 MHz
50	T500K99C0GW8570	857-50Z	±10%	15,000	NPO	0.1%	1 MHz
100	T101K99U2JW8570	857-100N	±10%	15,000	N750	0.1%	1 MHz
200	T201K99U2JV8570	857-200N	±10%	7,500	N750	0.1%	1 MHz
859S—Series Threaded Terminals							
50 pf	T500K99C0GZ859S	859S-50Z	±10%	20,000	NPO	0.1%	1 MHz
100	T101K99C0GZ859S	859S-100Z	±10%	20,000	NPO	0.1%	1 MHz
250	T251K99U2JZ859S	859S-250N	±10%	20,000	N750	0.1%	1 MHz
500	T501K99S3NW859S	859S-500N	±10%	15,000	N3300	0.2%	1 MHz

TYPICAL RF CHARACTERISTICS

Data is based on not exceeding the maximum rated voltage ("*" readings) or a 30°C maximum rise above a 25°C ambient in still air.

Reactive power ratings (KVAR) are calculated from voltage limited currents.

For operation in an air stream, multiply the R.F. MAX. AMPS by specific Fan Factor to obtain allowable higher current rating. Rated Working Voltage must not be exceeded.

5KVDC through 20KVDC RF RATED, Transmitting, Special Applications Ceramic Capacitors

CATALOG NUMBER	1 MHz R.F. MAX. AMPS	KVAR	Q TYP.	10 MHz R.F. MAX. AMPS	KVAR	Q TYP.	30 MHz R.F. MAX. AMPS	KVAR	Q TYP	FAN FACTORS FEET PER MINUTE 50	100	250	650
855-3Z	0.066*	0.23	2,000	0.66*	2.3	5,000	1.4	3.2	5,000	1.15	1.3	1.7	2.6
855-5Z	0.11*	0.38	5,000	1.1*	3.8	5,000	1.6	2.8	2,000	1.15	1.3	1.7	2.6
855-10N	0.22*	0.78	10,000	1.7	4.2	10,000	2.3	2.9	7,500	1.15	1.3	1.7	2.6
854-10Z	0.22*	0.78	10,000	1.8	5.4	10,000	2.1	2.3	7,500	1.1	1.2	1.4	1.8
853-20Z	0.44*	1.5	9,000	2.7	5.6	4,500	2.8	2.0	4,300	1.1	1.2	1.4	1.8
853-40N	0.89*	3.1	15,000	4.4	7.7	15,000	3.5	1.7	3,500	1.1	1.2	1.4	1.8
855A-3Z	0.066*	0.23	2,000	0.66*	2.3	5,000	1.4	3.2	5,000	1.15	1.3	1.7	2.6
855A-5Z	0.11*	0.38	5,000	1.1*	3.8	5,000	1.6	2.8	2,000	1.15	1.3	1.7	2.6
854A-10Z	0.22*	0.78	10,000	1.8	5.4	10,000	2.1	2.3	7,500	1.1	1.2	1.4	1.8
854A-20N	0.44*	1.55	7,000	3.1	7.5	12,000	3.4	3.0	15,000	1.1	1.2	1.4	1.8
853A-40N	0.89*	3.1	15,000	4.4	7.7	15,000	3.5	1.7	3,500	1.1	1.2	1.4	1.8
850S-25Z	0.84*	4.4	4,300	3.1	6.1	4,000	5.6	6.6	4,800	1.1	1.3	1.6	2.4
850S-50Z	1.7*	8.9	7,000	4.2	5.6	4,200	7.6	6.0	3,000	1.1	1.25	1.6	2.3
850S-50N	1.7*	8.9	7,000	5.0	7.9	7,600	8.5	7.7	4,000	1.1	1.25	1.6	2.3
850S-75N	2.5*	13.2	14,000	6.2	8.1	5,500	9.0	5.6	3,700	1.1	1.25	1.6	2.3
850S-100N	3.4	19.0	15,000	7.3	8.7	9,000	9.2	4.6	2,000	1.1	1.25	1.6	2.3
858S-500	1.1	0.39	300	2.5	0.21	120	3.0	0.1	55	1.1	1.2	1.4	2.0
858S-1000	1.4	0.3	200	3.1	0.15	–	3.7	0.076	–	1.1	1.2	1.4	2.0
857-25Z	1.7*	18.5	5,000	6.2	22.0	4,000	6.7	8.6	8,000	1.15	1.3	1.6	1.9
857-50Z	3.3*	35.4	4,000	7.4	18.0	4,500	8.1	7.1	3,000	1.15	1.3	1.6	1.9
857-100N	4.6	35.0	6,500	12.0	22.0	6,500	15.0	11.1	4,000	1.15	1.3	1.6	1.9
857-200N	5.1	23.0	5,000	8.5	6.2	4,000	15.0	6.0	2,000	1.15	1.3	1.6	1.9
859S-50Z	3.1	31.5	5,000	10.4	36.0	6,200	16.2	28.8	5,000	1.15	1.3	1.7	2.3
859S-100Z	3.8	23.5	4,500	12.9	27.4	4,500	19.4	20.6	3,000	1.15	1.3	1.7	2.3
859S-250N	9.2	52.0	5,000	13.0	11.0	3,000	35.0	25.0	1,000	1.15	1.3	1.7	2.3
859S-500N	6.7	14.0	3,800	14.0	5.9	800	23.0	5.4	–	1.15	1.3	1.7	2.3

CERAMIC CAPACITOR KITS

KIT-100MK-A RADIAL LEADED MULTILAYER MONO-KAP® CAPACITORS

KIT-100MK-A contains a wide assortment of the most popular radial leaded Mono-Kap multilayer capacitors in three industry standard temperature characteristics, COG (NPO), X7R, Z5U. 39 values, ranging from 10pf to 2.2mfd, in four tolerances, 50 and 100VDC Ratings.

CAP.	QTY.	VDC	CAT. NO.	CAP.	QTY.	VDC	CAT. NO.
10 pf	5	100	K100K15C0GHVAWA	.022 mf	5	50	K223K20X7RFVBWE
12 pf	5	100	K120K15C0GHVAWA	.033 mf	5	50	K333K20X7RFVBWG
15 pf	5	100	K150K15C0GHVAWA	.047 mf	5	50	K473K20X7RFVBWJ
18 pf	5	100	K180K15C0GHVAWA	.068 mf	5	50	K683K20X7RFVBWL
22 pf	5	100	K220K15C0GHVAWA	.1 mf	10	50	K104K20X7RFVBWN
27 pf	5	100	K270K15C0GHVAWA	.1 mf	5	50	K104M20X7RFVBWN
33 pf	5	100	K330K15C0GHVAWA	.1	10	100	K104K30X7RHVCWN
47 pf	5	100	K470K15C0GHVAWA	.22 mf	5	50	K224K30X7RFVCWT
56 pf	5	100	K560K15C0GHVAWA	.33 mf	5	50	K334K30X7RFVCWW
68 pf	5	100	K680K15C0GHVAWA	.47 mf	5	50	K474K40X7RFVCWY
82 pf	5	100	K820K15C0GHVAWA	.68 mf	5	50	K684K40X7RFVCXB
100 pf	10	100	K101K15C0GHVAWA	1.0 mf	5	50	K105K50X7RFVHXD
120 pf	5	100	K121K15C0GHVAWA	1.0 mf	5	50	K105M50X7RFVHXD
150 pf	5	100	K151K15C0GHVAWA	.0022 mf	5	50	K222M15Z5UFVAWA
220 pf	5	100	K221K15C0GHVAWA	.0033 mf	5	100	K332M15Z5UHVAWA
330 pf	5	100	K331K15C0GHVAWA	.0047 mf	5	100	K472M15Z5UHVAWA
470 pf	5	100	K471K20C0GHVBWA	.0068 mf	5	50	K682M15Z5UFVAWA
680 pf	5	100	K681K20C0GHVBWA	.01 mf	10	100	K103M15Z5UHVAWA
820 pf	5	100	K821K20C0GHVBWA	.01 mf	5	100	K103Z15Z5UHVAWA
.001 mf	10	100	K102K20C0GHVBWA	.01 mf	10	50	K103M15Z5UFVAWA
.0015 mf	5	100	K152K20C0GHVBWA	.01 mf	5	50	K103Z15Z5UFVAWA
.01 mf	10	50	K103J30C0GFVCWA	.022 mf	5	50	K223M15Z5UFVAWE
.01 mf	10	50	K103K30C0GFVCWA	.033 mf	5	50	K333M15Z5UFVAWG
150 pf	5	100	K151K15X7RHVAWA	.047 mf	5	100	K473M20Z5UHVBWJ
220 pf	5	100	K221K15X7RHVAWA	.047 mf	5	50	K473M20Z5UFVBWJ
330 pf	5	100	K331K15X7RHVAWA	.047 mf	5	50	K473Z20Z5UFVBWJ
470 pf	5	100	K471K15X7RHVAWA	.068 mf	5	50	K683M20Z5UFVBWL
680 pf	5	100	K681K15X7RHVAWA	.1 mf	10	100	K104M20Z5UHVBWN
.001 mf	5	100	K102K15X7RHVAWA	.1 mf	5	100	K104Z20Z5UHVBWN
.001 mf	5	100	K102M15X7RHVAWA	.1 mf	10	50	K104M20Z5UFVBWN
.0015 mf	5	100	K152K15X7RHVAWA	.1 mf	5	50	K104Z20Z5UFVBWN
.0022 mf	5	100	K222K15X7RHVAWA	.15 mf	5	50	K154M20Z5UFVBWR
.0033 mf	5	100	K332K15X7RHVAWA	.22 mf	5	50	K224M20Z5UFVBWT
.0047 mf	5	100	K472K15X7RHVAWA	.33 mf	5	50	K334M30Z5UFVCWW
.0056 mf	5	100	K562K15X7RHVAWA	.47 mf	5	50	K474M30Z5UFVCWY
.0068 mf	5	100	K682K20X7RHVBWA	.68 mf	5	50	K684M30Z5UFVCXB
.01 mf	10	50	K103K15X7RFVAWA	1.0 mf	10	50	K105M30Z5UFVCXD
.01 mf	10	50	K103M15X7RFVAWA	1.0 mf	5	50	K105Z30Z5UFVCXD
.01 mf	5	100	K103K20X7RHVBWA	1.0 mf	5	100	K105M40Z5UHVCXD
.015 mf	5	50	K153K15X7RFVAWC	2.2 mf	5	50	K225M40Z5UFVCXF

A = .100'' Spacing, #26 AWG.
B = .100'' Spacing, #24 AWG.
C = .200'' Spacing, #24 AWG.
H = .400'' Spacing, #22 AWG.

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CERAMIC CAPACITOR KITS

KIT-110MG-A AXIAL LEADED MULTI-LAYER MONO-GLASS® CAPACITORS

KIT-110MG-A contains a wide assortment of the most popular axial leaded Mono-Glass multilayer capacitors in three industry standard temperature characteristics, COG (NPO), X7R, Z5U. 37 values, ranging from 10pf to .47mf in four tolerances, 50WVDC Rating.

CAP.	QTY.	VDC	CAT. NO.	CAP.	QTY.	VDC	CAT. NO.
10 pf	5	50	G100J17C0GFVXWA	.001 mf	10	50	G102M17X7RFVXWA
12 pf	5	50	G120J17C0GFVXWA	.0015 mf	5	50	G152K17X7RFVXWA
15 pf	5	50	G150J17C0GFVXWA	.0022 mf	5	50	G222K17X7RFVXWA
18 pf	5	50	G180J17C0GFVXWA	.0033 mf	5	50	G332K17X7RFVXWA
22 pf	5	50	G220J17C0GFVXWA	.0047 mf	5	50	G472K17X7RFVXWA
27 pf	5	50	G270J17C0GFVXWA	.0056 mf	5	50	G562K17X7RFVXWA
33 pf	5	50	G330J17C0GFVXWA	.0068 mf	5	50	G682K17X7RFVXWA
47 pf	5	50	G470J17C0GFVXWA	.01 mf	20	50	G103K17X7RFVXWA
56 pf	5	50	G560J17C0GFVXWA	.01 mf	20	50	G103M17X7RFVXWA
68 pf	5	50	G680J17C0GFVXWA	.015 mf	5	50	G153K20X7RFVXWC
82 pf	5	50	G820J17C0GFVXWA	.022 mf	5	50	G223K25X7RFVXWE
100 pf	10	50	G101J17C0GFVXWA	.033 mf	5	50	G333K25X7RFVXWG
120 pf	5	50	G121J17C0GFVXWA	.047 mf	5	50	G473K30X7RFVXWJ
150 pf	5	50	G151J17C0GFVXWA	.068 mf	5	50	G683K30X7RFVXWL
220 pf	5	50	G221J17C0GFVXWA	.1 mf	20	50	G104K30X7RFVXWN
330 pf	5	50	G331J17C0GFVXWA	.1 mf	20	50	G104M30X7RFVXWN
470 pf	5	50	G471J17C0GFVXWA	.0047 mf	5	50	G472M17Z5UFVXWA
680 pf	5	50	G682J17C0GFVXWA	.0068 mf	5	50	G682M17Z5UFVXWA
820 pf	5	50	G821J25C0GFVXWA	.01 mf	20	50	G103M17Z5UFVXWA
.001 mf	10	50	G102J25C0GFVXWA	.01 mf	20	50	G103Z17Z5UFVXWA
.0015 mf	5	50	G152J30C0GFVXWA	.022 mf	5	50	G223M17Z5UFVXWE
.0022 mf	5	50	G222J30C0GFVXWA	.033 mf	5	50	G333M17Z5UFVXWG
.0033 mf	5	50	G332J30C0GFVXWA	.047 mf	5	50	G473M17Z5UFVXWJ
.0047 mf	5	50	G472J40C0GFVXWA	.047 mf	5	50	G473Z17Z5UFVXWJ
.0068 mf	5	50	G682J40C0GFVXWA	.068 mf	5	50	G683M25Z5UFVXWL
150 pf	5	50	G151K17X7RFVXWA	.1 mf	20	50	G104M17Z5UFVXWN
220 pf	5	50	G221K17X7RFVXWA	.1 mf	20	50	G104Z17Z5UFVXWN
330 pf	5	50	G331K17X7RFVXWA	.15 mf	5	50	G154M30Z5UFVXWR
470 pf	5	50	G471K17X7RFVXWA	.22 mf	5	50	G224M30Z5UFVXWT
680 pf	5	50	G681K17X7RFVXWA	.33 mf	5	50	G334M40Z5UFVXWW
.001 mf	10	50	G102K17X7RFVXWA	.47 mf	5	50	G474M40Z5UFVXWY

CERAMIC CAPACITOR KITS

KIT-63L-A LOW VOLTAGE DISCS

KIT-63L-A contains a popular assortment of low voltage Ultra-Kap® and general purpose ceramic dis capacitors. Units are offered in 3 to 100 volt DC ratings in 14 different values from .005 mf to 1.0m

CAP.	QTY.	VDC	CAT. NO.	CAP.	QTY.	VDC	CAT. NO.
.22 mf	5	3	U224P40Y5TAAATH	.1 mf	15	25	U104M59Y5PEABKM
.47 mf	5	3	U474P40Y5TAATF	.2 mf	5	25	U204M82Y5PEABKG
1.0 mf	5	3	U105P59Y5TAABTD	.01 mf	15	50	U103M29Y5PFAALJ
.05 mf	10	12	U503M29Y5PBAAJY	.022 mf	5	50	U223M47Y5PFAALJ
.1 mf	10	12	U104M40Y5PBAAJY	.033 mf	5	50	U333M47Y5PFABLJ
.2 mf	5	12	U204M59Y5PBABJX	.047 mf	5	50	U473M59Y5PFABLJ
.47 mf	5	12	U474M82Y5PBABJT	.05 mf	5	50	U503M59Y5PFABLJ
.01 mf	15	16	U103M20Y5PCAAKH	.1 mf	5	50	U104M82Y5PFABLJ
.022 mf	5	16	U223M29Y5PCAAKF	.01 mf	15	75	U103Z29Y5UGAAPK
.05 mf	5	16	U503M40Y5PCAAKE	.1 mf	5	75	U104Z69Y5UGABPK
.1 mf	15	16	U104M47Y5PCABKC	.01 mf	5	100	U103M29Y5THMBLK
.2 mf	5	16	U204M69Y5PCABMX	.005 mf	5	100	D502M29Z5VHAAEU
.3 mf	5	16	U304M82Y5PCABJW	.01 mf	15	100	D103M39Z5VHAAEU
.01 mf	15	25	U103M20Y5PEAAKW	.02 mf	5	100	D203M59Z5VHABEU
.022 mf	10	25	U223M29Y5PEAAKU	.025 mf	5	100	D253M59Z5VHABEU
.033 mf	5	25	U333M40Y5PEAAKR	.05 mf	5	100	D503M69Z5VHABEU
.05 mf	10	25	U503M40Y5PEAAKP	.1 mf	5	100	S104M72Z5VHAZAA

KIT-70H-A HIGH VOLTAGE DISCS

KIT-70H-A features a well balanced stock of high voltage, ceramic disc capacitors. Units include 3000 and 6000 volt DC rated discs in 33 values from 4.7pf to .005mf. A complete assortment of Philips Components GAP-KAP®, combination capacitor—spark-gap is also included in the kit.

CAP.	QTY.	VDC	CAT. NO.	CAP.	QTY.	VDC	CAT. NO.
4.7 pf	2	3000	D479M33S2LRAAAL	15 pf	2	6000	D150M66S2LUAZAA
47 pf	2	3000	D470M33S3NRAAAL	50 pf	2	6000	D500M66S3NUABAL
68 pf	2	3000	D680M33S3NRAAAL	75 pf	2	6000	D750M66S3NUABAL
82 pf	2	3000	D820M33S3NRAAAL	100 pf	2	6000	D101M66S3NUAZAA
100 pf	2	3000	D101M33Z5URAAEM	120 pf	2	6000	D121M66S3NUABAL
150 pf	2	3000	D151M33Z5URAAEM	150 pf	2	6000	D151M66S3NUABAL
220 pf	2	3000	D221M33Z5URAAEM	200 pf	2	6000	D201M66Z5UUABEM
270 pf	2	3000	D271M33Z5URAAEM	250 pf	2	6000	D251M66Z5UUABEM
390 pf	2	3000	D391M33Z5URAAEM	300 pf	2	6000	D301M66Z5UUABEM
470 pf	2	3000	D471M33Z5URAAEM	470 pf	2	6000	D471M66Z5UUABEM
500 pf	2	3000	D501M33Z5URAAEM	500 pf	2	6000	D501M66Z5UUABEM
680 pf	2	3000	D681M33Z5URAAEM	750 pf	2	6000	D751M66Z5UUABEM
750 pf	2	3000	D751M33Z5URAAEM	820 pf	2	6000	D821M66Z5UUABEM
820 pf	2	3000	D821M43Z5URAAEM	.001 mf	2	6000	D102M66Z5UUABEM
.001 mf	2	3000	D102M43Z5URAAEM	.0015 mf	2	6000	D152M66Z5UUABEM
.0015 mf	2	3000	D152M63Z5URABEM	.002 mf	2	6000	D202M76Z5UUABEM
.002 mf	2	3000	D202M63Z5URABEM	.0022 mf	2	6000	D222M76Z5UUAZAA
.0022 mf	2	3000	D222M63Z5URABEM	.75 pf*	2	1000	S758X44000NAZAA
.003 mf	2	3000	D302M63Z5URABEM	.001 mf*	2	1000	S102M40Z5PNAZAA
.0033 mf	2	3000	D332M63Z5URABEM	.004 mf*	2	3000	S402K96Z5PRAZAA
.0047 mf	2	3000	D472M73Z5URABEM	.01 mf*	2	1000	S103M69Z5UNAZAB
.005 mf	2	3000	D502M73Z5URABEM	.02 mf*	2	1000	S203M93Z5UNAZAA

CERAMIC CAPACITOR KITS

KIT-66T-A TEMPERATURE COMPENSATING DISCS

KIT-66T-A provides a balanced stock of temperature compensating ceramic disc capacitors. Discs are offered in NPO, N750 and N1500 temperature coefficients in 24 different values from 1.5pf to 220pf.

CAP.	QTY.	VDC	CAT. NO.	CAP.	QTY.	VDC	CAT. NO.
1.5 pf	2	600	D159D20C0KLAAAA	120 pf	2	600	D121J47C0GLABAA
2.2 pf	2	600	D229D20C0KLAAAA	5 pf	2	600	D509D20U2JLAAAA
3.3 pf	2	600	D339D20C0JLAAAA	10 pf	2	600	D100J20U2JLAAAA
4.7 pf	2	600	D479D20C0JLAAAA	15 pf	2	600	D150J20U2JLAAAA
6.8 pf	2	600	D689D20C0HLAAAA	22 pf	2	600	D220J20U2JLAAAA
10 pf	5	600	D100J20C0GLAAAA	25 pf	2	600	D250J20U2JLAAAA
15 pf	5	600	D150J20C0GLAAAA	27 pf	2	600	D270J20U2JLAAAA
20 pf	2	600	D200J20C0GLAAAA	33 pf	2	600	D330J29U2JLAAAA
22 pf	2	600	D220J29C0GLAAAA	47 pf	2	600	D470J29U2JLAAAA
25 pf	2	600	D250J29C0GLAAAA	68 pf	2	600	D680J39U2JLAAAA
27 pf	2	600	D270J29C0GLAAAA	75 pf	2	600	D750J39U2JLAAAA
33 pf	5	600	D330J29C0GLAAAA	100 pf	2	600	D101J39U2JLAAAA
47 pf	2	600	D470J40C0GLAAAA	100 pf	2	600	D101J39P3KLAAAA
50 pf	2	600	D500J40C0GLAAAA	120 pf	2	600	D121J39P3KLAAAA
68 pf	2	600	D680J40C0GLAAAA	150 pf	2	600	D151J47P3KLAAAA
75 pf	2	600	D750J40C0GLABAA	180 pf	2	600	D181J47P3KLAAAA
82 pf	2	600	D820J40C0GLABAA	200 pf	2	600	D201J59P3KLABAA
100 pf	5	600	D101J40C0GLABAA	220 pf	2	600	D221J59P3KLABAA

KIT-60D GENERAL PURPOSE DISCS

KIT-60D offers an assortment of the most widely used general purpose, ceramic disc capacitors. Discs include both 600 and 1000 volt DC ratings in 36 different values from 5pf to .05mf.

CAP.	QTY.	VDC	CAT. NO.	CAP.	QTY.	VDC	CAT. NO.
5 pf	5	1000	D509K20S2LNAAAL	390 pf pf	5	1000	D391K20Z5FNAAEM
10 pf	5	1000	D100K20S2LNAAAL	470 pf	5	1000	D471K20Z5FNAAEM
15 pf	5	1000	D150K20S2LNAAAL	500 pf	5	1000	D501K29Z5FNAAEM
20 pf	5	1000	D200K20S2LNAAAL	680 pf	5	1000	D681K29Z5RNAAEM
22 pf	5	1000	D220K20S2LNAAAL	820 pf	5	1000	D821K29Z5FNAAEM
25 pf	5	1000	D250K29S2LNAAAL	.001 mf	15	1000	D102K29Z5FNAAEM
33 pf	5	1000	D330K29S2LNAAAL	.001 mf	10	1000	D102P29Z5UNAAEM
47 pf	5	1000	D470K29S2LNAAAL	.0015 mf	5	1000	D152K39Z5RNAAEM
50 pf	5	1000	D500K29S3NNAAAL	.002 mf	10	1000	D202M39Z5UNAAEM
68 pf	5	1000	D680K29S3NNAAAL	.0022 mf	5	1000	D222M39Z5UNAAEM
100 pf	10	1000	D101K29S3NNAAAL	.003 mf	5	1000	D302M39Z5UNAAEM
120 pf	5	1000	D121K29S3NNAAAL	.0047 mf	5	1000	D472M47Z5UNAAEM
150 pf	5	1000	D151K29S3NNAAAL	.005 mf	5	1000	D502P59Z5UNABEM
180 pf	5	1000	D181K29S3NNAAAL	.005 mf	10	1000	D502M47Z5UNAAEM
200 pf	10	1000	D201K29S3NNAAAL	.0068 mf	5	1000	D682M59Z5UNABEM
220 pf	5	1000	D221K20Z5FNAAEM	.01 mf	5	1000	D103P69Z5UNABEM
250 pf	5	1000	D251K20Z5FNAAEM	.01 mf	15	1000	D103M59Z5UNABEM
270 pf	5	1000	D271K20Z5FNAAEM	.01 mf	5	600	D103P59Z5ULABED
300 pf	5	1000	D301K20Z5FNAAEM	.02 mf	5	600	D203Z69Z5ULABED
330 pf	5	1000	D331K20Z5FNAAEM	.05 mf	5	600	S503Z85Z5ULAZAA

CERAMIC CAPACITOR KITS

KIT-120MA-A ACIAL LEADED MULTI-LAYER MONOAXIAL® CAPACITORS

KIT-120MA-A contains a wide assortment of the most popular axial leaded MonoAxial® multilayer capacitors in three industry standard temperature characteristics, C0G (NPO), X7R, Z5U, 89 values ranging from 10 pf to .47 mf in four tolerances 50 and 100 WVDC rating.

CAP.	QTY	VDC	DISTRIBUTOR PART NUMBER	CAP.	QTY	VDC	DISTRIBUTOR PART NUMBER
10 pf	5	100	A40A100J	.0015 mf	5	100	A41A152K
15 pf	5	100	A40A150J	.0022 mf	5	100	A41A222K
18 pf	5	100	A40A180J	.0033 mf	5	50	A41C332K
22 pf	5	100	A40A220J	.0047 mf	5	50	A41C472K
27 pf	5	100	A40A270J	.01 mf	40	50	A41C103K
33 pf	5	100	A40A330J	.015 mf	5	50	A41C153K
47 pf	5	100	A40A470J	.022 mf	5	50	A41C223K
68 pf	5	100	A40A680J	.033 mf	5	50	A41C333K
82 pf	5	100	A40A820J	.047 mf	5	50	A41C473K
100 pf	10	50	A40C101J	.1 mf	40	50	A41C104K
150 pf	5	50	A40C151J	.01 mf	20	50	A43C103M
220 pf	5	50	A40C221J	.01 mf	20	50	A43C103Z
330 pf	5	50	A40C331J	.022 mf	5	50	A43C223M
470 pf	5	50	A40C471J	.033 mf	5	50	A43C333M
680 pf	5	50	A40C681J	.047 mf	5	50	A43C473M
.001 mf	10	50	A40C102J	.047 mf	5	50	A43C473Z
220 pf	5	100	A41A221K	.1 mf	40	50	A43C104M
330 pf	5	100	A41A331K	.1 mf	40	50	A43C104Z
470 pf	5	100	A41A471K	.22 mf	5	50	A43C224M
680 pf	5	100	A41A681K	.33 mf	5	50	A43C334M
.001 mf	20	100	A41A102K	.47 mf	5	50	A43C474Z

ALSO AVAILABLE FROM YOUR PHILIPS COMPONENTS AUTHORIZED DISTRIBUTOR.

PHILIPS COMPONENTS

EIA Designations Of Temperature Characteristics And Tolerances For Ceramic Capacitors

CAPACITANCE TOLERANCE CODES

EIA	Tolerance	EIA	Tolerance
A	±0.15 pF	K	±10%
B	±0.1 pF	L	±15%
C	±0.25 pF	M	±20%
D	±0.5 pF	N	±30%
F	±1% or ±1 pF	P	GMV or –0%, +100%
G	±2% or ±2 pF	W	–20%, +40%
H	±2.5%	Y	–20%, +50%
J	±5%	Z	–20%, +80%

TEMPERATURE CHARACTERISTICS
GENERAL APPLICATION CAPACITORS

X **7** **R**

Minimum Temperature	
X	–55°C
Y	–30°C
Z	+10°C

Minimum Temperature	
2	–45°C
4	+65°C
5	+85°C
6	+105°C
7	+125°C

Maximum Capacitance Change Over Temperature Range			
A	±1.0%	P	±10%
B	±1.5%	R	±15%
C	±2.2%	S	±22%
D	±3.3%	T	–33%, +22%
E	±4.7%	U	–56%, +22%
F	±7.5%	V	–82%, +22%

Example: X7R means a max. cap. change of ±15% over the temperature range of –55°C to +125°C

TEMPERATURE COMPENSATING CAPACITORS

C O G

Temperature Coefficient in ppm/°C			
Significant Figures		Multiplier	
C	0.0	0	–1
M	1.0	1	–10
P	1.5	2	–100
R	2.2	3	–1000
S	3.3	5	+1
T	4.7	6	+10
U	7.5	7	+100
		8	+1000

Tolerance in ppm/°C	
G	±30
H	±60
J	±120
K	±250
L	±500
M	±1000
N	±2500

Example: COG is 0±30ppm/°C.

GLOSSARY

AC:
Alternating Current

Aging:
The Capacitance Value of Class II, III and IV ceramic capacitors decreases with age. This decrease, which is very rapid for the first few hours, diminishes with time and becomes almost imperceptible after about one month.

Bias Voltage:
A voltage, usually DC, used to set the operating point of a circuit above or below a reference voltage.

Blocking Capacitor:
A capacitor which limits the flow of DC or low frequency AC without materially affecting the flow of high frequency AC.

By-pass Capacitor:
A capacitor which provides a low impedance path around a circuit element.

Capacitance:
The property of a system of two or more conductors which permit it to store electrical energy in an electrostatic field between them. The electrical capacity for ceramic capacitors is measured in either μF (micro-farad, which is 10^{-6} farad) of pF (pico-farad, or $\mu\mu$F, which is 10^{-12} farad).

The formula for capacitance in a system of two plates, as in a single disc construction ceramic disc capacitor, is:

C in pF = .2249 KA/t or (KA)/(4.45t), where

K is the dielectric constant of the material separating the two electrodes

A is the surface area in square inches where the two electrodes overlap

t is the dielectric thickness in inches

This formula disregards edge effects which for materials with dielectric constants of approximately 1000 or greater may be disregarded for practical purposes.

From the above formula, one may see that the capacitance of any unit is directly proportional to the electrode area (diameter for discs and length and width, as well as number of layers, for multilayers) and the dielectric constant of the material, and inversely proportional to the thickness of the ceramic. Since different manufacturers of ceramic capacitors employ different dielectric materials, with different dielectric constants, it can be easily understood why differences in size for a given capacitance value occur.

Capacitive Reactance (X_c):
Opposition offered to the flow of alternating current by a capacitor or any unit having capacitance.

Coupling Capacitor:
A capacitor used to transfer signals of a specific frequency from one circuit to another circuit.

Curie Point:
In ferro electric dielectrics, the temperature(s) at which the dielectric constant reaches peak values. At the curie point temperature(s) the crystal form is changing from cubic to tetragonal. Manufacturers use modifiers in their specific ceramic formulations to shift curie points such that the rapid change in capacitance value which normally occurs around the curie point will have no effect on the specified characteristics of the capacitor over its specified temperature range.

Dielectric Constant (K) (Permitivity):
The ratio of the ability of a dielectric material to store electrostatic energy to that stored by a vacuum as the dielectric utilizing the same electrode system.

Dielectric Strength (Dielectric Withstanding Voltage) (DWV)
This is the maximum potential gradient that a dielectric can withstand before it ruptures or a conductive path is formed through (or around) it. Since the dielectric strength is affected by many factors, its measurement will result in large variations unless the conditions of test are standardized.

DWV testing of unencapsulated units of voltages around 1KVDC and higher are generally not recommended, unless special design criteria are used to prevent arc-over between the electrodes through the air surrounding the part.

Dissipation Factor
The dissipation factor of a capacitor is the ratio of energy dissipated to energy stored in the dielectric. DF is a measurement of the internal quality of the capacitor.

Electronic Industry Association (EIA):
An industry sponsored body, comprised of Manufacturers, Users and Equipment Manufacturers, which sets standards for Electronic Components, such as Capacitors, Resistors, Coils, Connectors, Computer Keyboards, Display Tubes; it also sets standards for Packaging of Components, Measurement Methods of Components, Handling Methods for Components, etc.

Equivalent Series Resistance:
All internal AC series resistance of a Capacitor treated as single resistance.

Impedance (Z):
The total opposition offered to the flow of alternating current at a given frequency.

Inductive Reactance (X_L):
Opposition offered to the flow of alternating current by coils, leads, solder connections or other inductors.

Insulation Resistance (IR):
The ratio of the DC voltage applied to the terminals of a capacitor and the resulting leakage current flow after the initial charging current has ceased. It includes both the volume and surface resistance. Industry capacitor testing is typically performed after two minutes charging time.

For many types of capacitors it is expressed as the product of Insulation Resistance and capacitance values (megOhm-microfarad).

KiloHertz (KHz):
Unit of frequency, 10^3 cycles per second; this is the standard measurement frequency for EIA Class II, III and IV ceramic capacitors for both capacitance and DF measurement.

Life Test:
An accelerated test, designed to measure the ability of a capacitor to withstand its rated operating conditions for a lengthy, useful life. The test conditions depend upon the rating of the capacitor. For example, for ceramic capacitors, rated 1000VDC or less, a common test consists of subjecting the part to a DC Voltage equal to two times its rated working voltage for 250, 500 or 1000 hours at either 85°C or 125°C. Limits are set, per EIA Standard RS-198C, for changes in the properties of the capacitor after this conditioning. For Class II, III and IV type capacitors, the initial measurements are typically taken some 24 hours after de-aging the parts for one hour at 150°C ± 5°C. The measurements upon the completion of the test are again taken approx. 24 hours after completion. This 24 hour period insures that variances in capacitance are not due to the life test conditioning.

MegaHertz (MHz):
Unit of Frequency, 10^6 cycles per second. This is alwo the standard test frequency for EIA Class I capacitors (such as NPO or COG, N330, etc.) for both capacitance and DF (1/Q) measurement.

Multilayer Capacitor:
A ceramic capacitor, made up of several alternately stacked electrodes, separated by ceramic dielectric layers, fired into a single monolithic package.

Q:
Q or Quality Factor is the ratio of energy dissipated to energy stored and is therefore considered the reciprocal of DF when tested at low frequencies (1MHz).

Rated Working Voltage:
The nominal voltage at which a capacitor can be continuously operated without derating. Ceramic capacitors are typically rated with a DC rating; the AC component should typically not exceed 10% of the DC rating and the combination of AC and DC voltage should not exceed the rated voltage. An example: A 50VDC rated unit will be subjected to 2VAC, can this be used in a 24VDC circuit? 2VAC converts to approx. 20VDC; when this is deducted from the 50VDC rating, this leaves 30VDC. Since the circuit is only 24VDC, the unit will be used within the design voltage limits.

Resonant Frequency (f0):
The frequency at which the total inductive and capacitive reactance of a capacitor (or of the components in a circuit) are equally low. This results in the component's impedance being equivalent to a pure resistor.

TANTALUM CAPACITORS
QUICK REFERENCE INDEX

TYPE	MIL-SLASH NO.	DESIGNATION	STYLE	DESCRIPTION	CAPACITANCE RANGE	VOLTAGE RANGE	PAGE
WET SLUG MIL-C-3965							210
	/1	CL14 CL16	43XW	Hermetic Seal, Screw Mount, Cylindrical Case	3.5- 200 uf	20-630v	212
	/19	CL17 CL18	43XW	Hermetic Seal, Stud Mount, Cylindrical Case	12-1300 uf	30-630v	214
	/21	CL55	43JW	Hermetic Seal, Rectangular Module	70-2400 uf	15-150v	216
	/4	CL64 CL65	40LW	Elastomer Seal, Axial Lead, Tubular Case	1.7- 560 uf	6-125v	218
	/24	CL66 CL67	40SW	Hermetic Seal, Axial Lead, Tubular Case	1.7- 560 uf	6-125v	220
	MIL-C-39006			Established Reliability			222
	/18	CLR10	43XW	Extended Range, Axial Lead, Tubular Case	2.0- 140 uf	8-360v	225
	/19	CLR14	43XW	Extended Range, Cylindrical Case, Solder Lug Terminal	3.5- 200 uf	20-630v	226
	/20	CLR17	43XW	Extended Range, Cylindrical Case, Solder Lug Terminal	12-1300 uf	30-630v	227
	/09	CLR65- 8000	40SW	Glass-to-Tantalum Hermetic Seal, Axial Lead, Tubular Case	1.7-1200 uf	6-125v	229
	/22	CLR79	40AW	Hermetic Seal, Non-Silver Case, Axial Lead, Tubular Case	1.7-1200 uf	6-125v	233
	/25	CLR81	40BW	Extended Range, Hermetic Seal, Non-Silver Case, Axial Lead, Tubular Case	6.8-2000 uf	6-125v	238
WET FOIL MIL-C-3965							280
	/17	CL20 CL21	40AF	Polar, Etched Foil, Tubular Case, Axial Lead	1- 580 uf	15-150v	281
	/18	CL22 CL23	40BF	Non-Polar, Etched Foil, Tubular Case, Axial Lead	0.5- 350 uf	15-150v	282
	/15	CL30 CL31	40AG	Polar, Plain Foil, Tubular Case, Axial Lead	0.27- 300 uf	3-300v	283
	/16	CL32 CL33	40BG	Non-Polar, Plain Foil, Tubular Case, Axial Lead	0.12- 400 uf	3-300v	284
	/9	CL51	43KG	Polar, Plain Foil, KSR™, Hermetic Rectangular Module	40- 960 uf	15-150v	288
	/10	CL52	43JG	Non-Polar, Plain Foil, KSR™, Hermetic Rectangular Module	20- 600 uf	15-150v	288
	/11	CL53	43KF	Polar, Etched Foil, KSR™, Hermetic Rectangular Module	70-3500 uf	15-150v	289
	/12	CL54	43JF	Non-Polar, Etched Foil, KSR™, Hermetic Rectangular Module	35-2100 uf	15-150v	289
	/22	CL70 CL71	40RF	Polar, High Etched Foil, Tubular Case, Axial Lead	1.6- 920 uf	15-150v	285
	/23	CL72 CL73	40SF	Non-Polar, High Etched Foil, Tubular Case, Axial Lead	0.75- 590 uf	15-150v	286
	MIL-C-39006			Established Reliability			291
	/01	CLR25	40EF	Polar, Etched Foil, Hermetic and Non-Hermetic, Axial Lead	1.0- 580 uf	15-150v	292
	/02	CLR27	40FF	Non-Polar, Etched Foil, Hermetic and Non-Hermetic, Axial Lead	0.5- 350 uf	14-150v	293
	/03	CLR35	40EG	Polar, Plain Foil, Hermetic and Non-Hermetic, Axial Lead	0.35- 160 uf	15-200v	294
	/04	CLR37	40FG	Non-Polar, Plain Foil, Hermetic and Non-Hermetic, Axial Lead	0.15- 100 uf	15-200v	295
	/16	CLR71	40TF	Polar, High Etched Foil, Hermetic and Non-Hermetic, Axial Lead	1.6- 920 uf	15-150v	296
	/17	CLR73	40VF	Non-Polar, High Etched Foil, Hermetic and Non-Hermetic, Axial Lead	0.75- 590 uf	15-150v	297
SOLID SLUG MIL-C-26655B							
		CS12 CS13	40SS	Hermetic Seal, Axial Lead, Tubular Case	.0047- 330 uf	6-100v	245
	MIL-C-39003			Established Reliability			251
	/02	CSR09	40TS	Polar, Miniature, Hermetic Seal, Axial Lead, Tubular Case	.047- 18 uf	6- 75v	254
	/01	CSR13	40SS	Polar, Hermetic Seal, Axial Lead, Tubular Case	.0047- 330 uf	6-100v	256
	/09	CSR21	40ZS	Polar, High Frequency Hermetic, Tubular Case, Axial Lead	5.6- 330 uf	6- 50v	265
	/03	CSR23	40XS	Polar, Extended Range, Hermetic Seal, Axial Lead, Tubular Case	1.2-1000 uf	6- 50v	268
	/06	CSR33	40YS	Polar, Extended Range, Hermetic Seal, for Low Impedance Application	1.2-1000 uf	6- 50v	271
	/04	CSR91	40NS	Non-Polar, Hermetic Seal, Axial Lead, Tubular Case	.0023- 160 uf	6-100v	274
WET SLUG			40AW	Hermetic, Non-Silver Case, Axial Lead, Tubular Case	1.7-1200 uf	6-125v	298
			40BW	Extended Range Hermetic, Non-Silver Case, Axial Lead, Tubular Case	6.8-2000 uf	6-125v	305
			40EW	Extended Range, Polar, Non-Hermetic, Tubular, Axial	6.8-1800 uf	6-125v	313
			43JW	Hermetic, Rectangular Module, Spade Lugs	35-22000 uf	6-150v	320
			40LW	Polar, Non-Hermetic, Tubular, Axial Lead	1.7-1100 uf	6-125v	329
			40SW	Hermetic, Polar, Glass to Tantalum Seal, Tubular, Axial	1.7-1200 uf	6-125v	336
			40TW	Hermetic, Non-Silver Case, Tubular, Axial, High Temp.	1.7-1200 uf	6-125v	341
			43XW	Hermetic, Cylindrical Case, Stud or Screw Mount	3.5-1300 uf	20-630v	348
			40YW	Miniature, Non-Acid Electrolyte, Polar, Tubular, Non-Hermetic	0.1- 320 uf	6- 60v	352
SOLID SLUG			41GS	Polar, Dipped, Non-Hermetic, Miniature, Radial Lead	0.1- 680 uf	3- 50v	355
			40MS	Polar, Molded, Non-Hermetic, Axial Lead	0.1- 68 uf	2- 50v	359
			40NS	Non-Polar, Hermetic, Tubular Case, Axial Lead	.0023- 160 uf	6-100v	365
			41PS	Polar, Non-Hermetic, Rectangular Plastic Case, Radial Lead	0.1- 220 uf	6- 50v	369
			40SS	Polar, Standard Hermetic, Tubular Case, Axial Lead	.0047- 330 uf	6-100v	373
			40TS	Polar, Miniature Hermetic, Tubular Case, Axial Lead	.0047- 39 uf	4-100v	380
			40XS	Polar, Extended Range, Hermetic Tubular, Axial Lead	0.82-1000 uf	6- 60v	384
			40YS	Polar, Extended Range, Hermetic, For Low Impedance Applications	1.0-1000 uf	6- 60v	388
			40ZS	Polar, High Frequency Hermetic, Tubular Case, Axial Lead	5.6- 330 uf	6- 50v	392
APPLICATION DATA: WET, FOIL, SOLID							395-401
TANTALUM CAPACITOR PACKAGING INFORMATION							402

MILITARY

INDUSTRIAL

MIL-C-3965
Military Style Tantalum Capacitors

MIL-C-3965

DESIGN AND CONSTRUCTION
Each capacitor is enclosed in a metallic case and is effectively sealed against the entry of contaminants and leakage or evaporation of the electrolyte.

TERMINALS
All terminals are permanently secured internally and externally as required in MIL-C-3965. All external joints are soldered or welded, all terminals used for soldered connections are hot-tin-dipped or soldered to facilitate soldering.

DC LEAKAGE
After a five minute, ±½ minute period with full rated working voltage across the capacitor, the leakage current will not exceed the maximum shown in the table.

CAPACITANCE
Capacitors are tested in accordance with method 305 of MIL-STD-202, using a polarized capacitance bridge. The following details apply:

A. Test conditions: Measurements are made at a frequency of 120 ±5Hz. The AC voltage shall be limited to 30 percent of the rated DC working voltage or 1 volt root-mean-square (RMS), whichever is smaller. The polarizing and 120 Hz. voltages are such that the peak AC voltage is less than the DC voltage, and the sum of peak AC and DC voltages does not exceed the rated DC working voltage.
B. Measurement accuracy — within ±2 percent.
C. Magnitude of polarizing voltage — of such magnitude as to cause no reversal of polarity.

STABILITY AT REDUCED AND HIGH TEMPERATURES
The measurements specified below are made in the order shown at thermal stability. Thermal stability has been reached when no further change in capacitance is observed between two successive measurements taken at 15 minute intervals.

The capacitor values at −55°C and the applicable high test temperatures do not change more than the percentage specified in the tables from the initial values at 25°C. The second and third capacitance measurement at 25°C do not change more than ±5% from the initial values at 25°C.

Step	Temperature	Measurements
1	25°C	DC Leakage Capacitance Equivalent Series Resistance
2	-55°C +0°C -3°C	Impedance Capacitance
3	25°C	DC Leakage Capacitance Equivalent Series Resistance
4	High Test Temperature +3°C -0°C	DC Leakage Capacitance Equivalent Series Resistance
5	25°C	DC Leakage Capacitance Equivalent Series Resistance

VIBRATION
When testing in accordance with method 204 of MIL-STD-202 as modified by MIL-C-3965, these capacitors will not have intermittent contacts or exhibit open or short circuiting while under vibration or, after testing, be mechanically damaged.

SALT SPRAY (Corrosion)
There will be no harmful corrosion, and at least 90% of any exposed metallic surface of the capacitors will be unaffected when subjected to the corrosion test specified in Standard MIL-STD-202, method 101, test condition B.

THERMAL SHOCK AND IMMERSION
When tested as specified in MIL-STD-202 under method 107 and method 104, the capacitors will not leak electrolyte or evidence any harmful corrosion. The DC leakage shall not exceed 125 percent, and the equivalent series resistance will not exceed 115 percent, of their values tabulated in the table. The capacitance will not change more than ±5 percent from that initially measured.

INSULATING SLEEVES
Style CL65 has insulating sleeves which, when tested as specified in MIL-C-3965, will not exhibit dielectric breakdown, and the insulation resistance will not be less than 100 meg ohms.

TERMINAL STRENGTH

All terminals will withstand a pull of three pounds $^{+2}_{-0}$ ounces in axial direction for 30 seconds. The lead will withstand insertion into the hold of a fixture so that the lower side of the weld or soldered joint is flush with the fixture. The case can then be forced over in such a manner that the tantalum stub is maintained in its axial position as close as possible while bending the lead until the end of the case touches the top surface of the fixture. When the case is returned to its normal position, one bend has been completed. The capacitors will withstand four bends in alternating directions.

SURGE VOLTAGE

The capacitors will withstand 1000 cycles of the DC surge voltage shown below. The ambient temperature during cycling is the applicable high test temperature specified by the appropriate letter symbol.

Capacitors, when subjected to 1000 cycles of the DC surge voltage specified above will not exhibit any electrical intermittance during test. On completion of testing there will be no visual evidence of mechanical damage or leakage of the electrolyte. The ambient temperature during cycling shall be the applicable high test temperature. (See characteristic in the coding system).

Each cycle consists of a 30 second surge-voltage application followed by a 5½ minute discharge period. Voltage application is made through a resistance of 1000 ±100 ohms in series with the capacitor and the voltage source. Each surge voltage cycle shall be performed in such a manner that the capacitor is discharged through the 1000 ohm resistor at the end of the 30 second application.

MOISTURE RESISTANCE

When tested in accordance with method 106 of Standard MIL-STD-202 as modified by MIL-C-3965, the capacitors will not evidence any harmful corrosion and will meet the following electrical requirements.

DC Leakage — Will not exceed 125 percent of the initial requirements. (See table).

Capacitance — Will not change more than ±10 percent from that measured prior to the start of testing.

Dissipation Factor — Will not exceed 115 percent of the initial requirement. (See table).

Sleeved capacitors will meet the requirements listed under insulating sleeves after exposure to the above moisture resistance test.

LIFE

These capacitors, after being exposed for 2000 hours to the applicable high test temperature with continuous application of the DC working voltage, will meet the following requirements:

Leakage Current — Original requirements (See Table).

Capacitance — +25 - 15 percent of initial measurement.

Equivalent Series Resistance — 130 percent of initial requirement. (See table).

BAROMETRIC PRESSURE (Reduced)

When tested in accordance with method 105 of Standard MIL-STD-202 as modified by MIL-C-3965 and stabilized at an atmospheric pressure of 0.82 inches of mercury for 5 minutes, will not leak electrolyte, show intermittent contacts or mechanical damage.

MARKING

Capacitors are marked in accordance with MIL-C-3965 with military type designation, capacitance in mfd., DC working voltage, date of manufacture (indicated by the number of the month followed by a hyphen and the last two figures of the year), and an arrow indicating the negative terminal, mfg. source code or logo.

WORKMANSHIP

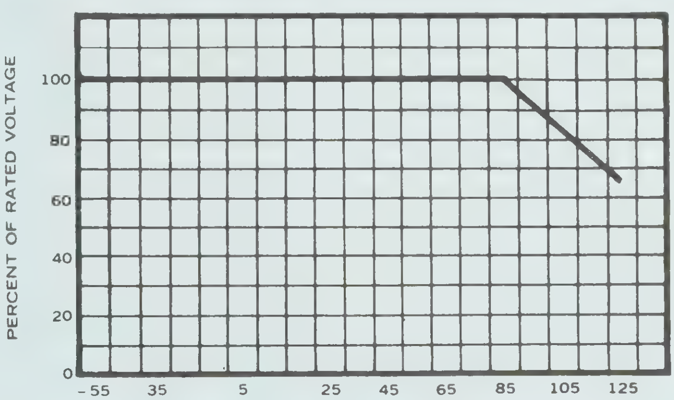
Workmanship is such as to permit the capacitors to meet all the requirements of this specification.

QUALITY ASSURANCE

Statistical sampling and inspection are in accordance with Standard MIL-STD-105. The acceptable quality levels (AQL) are as specified in MIL-C-3965.

Symbol	DC Working Voltage	Surge Voltage at 85°C
	VOLTS	VOLTS
B	6	6.9
C	8	9.2
D	10	11.5
E	15	17.2
G	25	28.8
H	30	34.5
J	50	57.5
K	60	69.0
L	75	86.2
N	100	115.0
P	125	144.0

TEMPERATURE IN DEGREES CENTIGRADE
(THIS CURVE IS USED IN CONJUNCTION WITH THE TABLE)



AMBIENT TEMPERATURE

APPLICABLE TO CHARACTERISTIC "C" CAPACITORS

NOTE:
MIL-C-3965 INACTIVE
FOR NEW DESIGN

MIL-C-3965

Military Style Tantalum Capacitors

MIL-C-3965/1
STYLES CL14 & CL16

DESIGN AND CONSTRUCTION
Each capacitor consists of an assembly of tubular wet tantalum capacitors potted in a metal case and hermetically sealed with each terminal insulated from the capacitor case.

TERMINALS
Terminals are the solder-lug or screw mount type.

D.C. LEAKAGE
DCL shall be measured following a rated voltage electrification period not exceeding 5 minutes. The DCL shall not exceed the value shown for each specific rating.

CAPACITANCE
Capacitance shall be determined in accordance with Method 305 of MIL-STD-202 at 120 ±5Hz. The magnitude of the A.C. voltage shall not exceed 1.0 vrms and the D.C. bias shall not exceed 2.2 VDC.

DISSIPATION FACTOR
When measured as specified above, the D.F. for capacitors shall not exceed value shown in table.

TEMPERATURE CHARACTERISTICS

	-55 C	+25 C	85 C	125 C
Capacitance	-60%(20v) -45%(30v) -35%(>30v)	±5% of retrace	+15%(>30v) +10%(>30v)	+20%(>26v) +10%(>26v)
Dissipation Factor	——	Initial Limits	Initial Limits	Initial Limits
DCL	——	(See Table)	(See Table)	(See Table)
Impedance	(See Table)	——	——	——

LIFE TEST
Following a 2000 hour life test at 85°C and full rated voltage applied:
1. The DCL shall not exceed initial limit
2. The capacitance change shall not exceed ±15%
3. The Dissipation Factor shall not exceed initial measurement.

The above limits also apply following a life test of 2000 hours at 125°C with derated voltage applied, except D.F. which shall not exceed 130% of initial limit.

MILITARY CODING SYSTEM

CL14 B F 201 U P G

- SEAL TYPE — G = Hermetic
- POLARITY — P = Polar
- CAPACITANCE TOLERANCE — U = +75 — 15%
- CAPACITANCE in Microfarads first two digits are significant figures, third digit is number of zeroes to follow: i.e., 961 = 960uf.
- OPERATING VOLTAGE at 85°C.

F = 20	M = 90	T = 360	W = 630
H = 30	R = 180	U = 450	
K = 60	S = 270	V = 540	

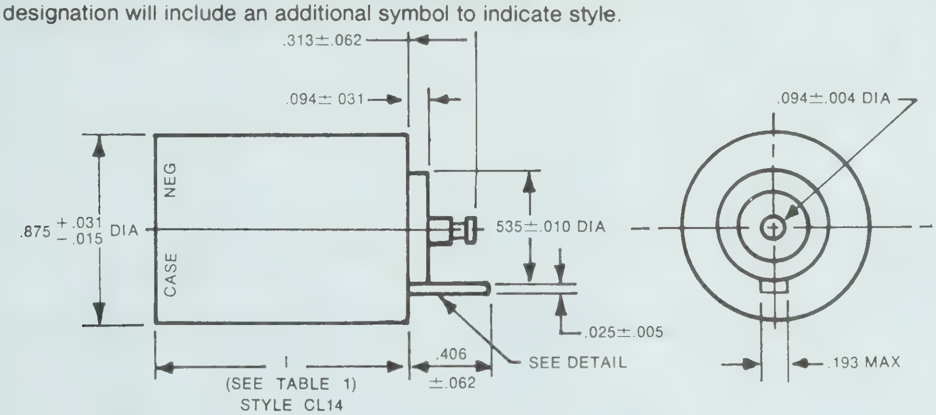
- TEMPERATURE CHARACTERISTIC: B = full operating voltage -55°C to 85°C and linearly derated to ⅔ rated voltage at 125°C.
- STYLE: Fixed non solid electrolyte sintered anode tantalum capacitor.
  CL14 — stud and lug mount
  CL16 — screw and lug mount

NOTE: Military number does not designate case size. See table for specific capacitance and voltage rating.

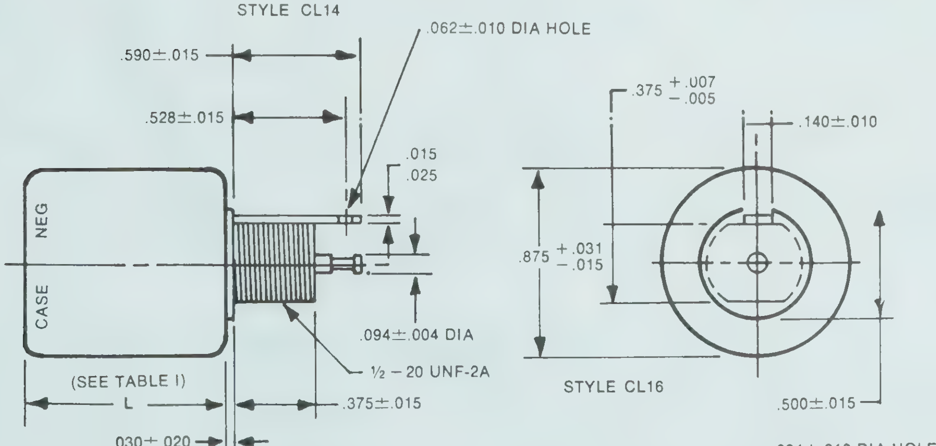
MIL-C-3965/1
STYLES CL14 & CL16

Type Designation 1/	Voltage Rated (85°C)	Voltage Derated (125°C)	Voltage Surge (85°C)	Capacitance	DC Leakage (max.) 25°C	DC Leakage (max.) 85°C	DC Leakage (max.) 125°C	Dissipation Factor (max.)	Impedance (max.)	Dimension L ±.062 (1.57)
	volts, dc	volts, dc	volts, dc	uF	uA	uA	uA	percent	ohms	inches (mm)
CL1-BF101UPG	20	18	23	100.0	10	50	80	21.0	30	0.540(13.72)
CL1-BF201UPG	20	18	23	200.0	16	80	128	36.0	20	0.732(18.59)
CL1-BH750UPG	30	26	34.5	75.0	11	55	88	15.0	45	0.540(13.72)
CL1-BH151UPG	30	26	34.5	150.0	13	90	104	29.0	30	0.732(18.59)
CL1-BK400UPG	60	52	69	40.0	12	60	96	8.2	65	0.540(13.72)
CL1-BK800UPG	60	52	69	80.0	19	95	152	16.0	35	0.732(18.59)
CL1-BM250UPG	90	78	103	25.0	11	55	88	5.1	90	0.540(13.72)
CL1-BM500UPG	90	78	103	50.0	18	90	144	10.0	45	0.732(18.59)
CL1-BR120UPG	180	155	207	12.0	11	55	88	5.1	180	0.920(23.37)
CL1-BR250UPG	180	155	207	25.0	18	90	144	10.0	90	1.300(33.02)
CL1-BS080UPG	270	235	310	8.0	11	55	88	5.1	270	1.270(32.36)
CL1-BS160UPG	270	235	310	16.0	18	90	144	10.0	135	1.865(47.37)
CL1-BT060UPG	360	310	414	6.0	11	55	88	5.0	360	1.635(41.53)
CL1-BT120UPG	360	310	414	12.0	18	90	144	10.0	180	2.420(61.47)
CL1-BU050UPG	450	390	518	5.0	11	55	88	4.9	450	2.000(50.80)
CL1-BU100UPG	450	390	518	10.0	18	90	144	9.8	225	2.980(75.69)
CL1-BV040UPG	540	470	621	4.0	11	55	88	5.1	540	2.365(60.07)
CL1-BV080UPG	540	470	621	8.0	18	90	144	10.0	270	3.532(89.71)
CL1-BW3R5UPG	630	545	724	3.5	11	55	88	5.0	630	2.720(69.09)
CL1-BW070UPG	630	545	724	7.0	18	90	144	10.0	315	4.062(103.17)

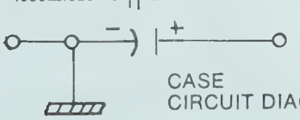
1/ Complete type designation will include an additional symbol to indicate style.



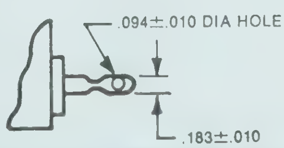
STYLE CL14



STYLE CL16



CASE
CIRCUIT DIAGRAM



DETAIL OF CL14
SOLDER-LUG TERMINAL

MIL-C-3965

Military Style Tantalum Capacitors

MIL-C-3965/19
STYLES CL17 & CL18

DESIGN AND CONSTRUCTION
Each capacitor consists of an assembly of tubular wet tantalum capacitors potted in a metal case and hermetically sealed with each terminal insulated from the capacitor case.

TERMINALS
Terminals are the solder-lug or screw mount type.

D.C. LEAKAGE
DCL shall be measured following a rated voltage electrification period not exceeding 5 minutes. The DCL shall not exceed the value shown for each specific rating.

CAPACITANCE
Capacitance shall be determined in accordance with Method 305 of MIL-STD-202 at 120 ±5Hz. The magnitude of the A.C. voltage shall not exceed 1.0 vrms and the D.C. bias shall not exceed 2.2 VDC.

DISSIPATION FACTOR
When measured as specified above, the D.F. for capacitors shall not exceed value shown in Table.

TEMPERATURE CHARACTERISTICS

	-55°C	+25°C	85°C	125°C
Capacitance	(See Table)	±5% of retrace	+20% △C	+25% △C
Power Factor	———	Initial Limits	Initial Limits	Initial Limits
DCL	———	(See Table)	(See Table)	(See Table)
Impedance	(See Table)	———	———	———

LIFE TEST
Following a 2000 hours life test at 85°C and full rated voltage applied:

1. The DCL shall not exceed initial limit
2. The capacitance change shall not exceed ±20%
3. The Dissipation Factor shall not exceed initial limit

The above limits also apply following a life test of 2000 hours at 125°C with derated voltage applied, except D.F. which shall not exceed 150% of initial limit.

MILITARY CODING SYSTEM

CL17 B E 961 M P G

- G — SEAL TYPE — G = Hermetic
- P — POLARITY — P = Polar
- M — CAPACITANCE TOLERANCE — M = ±20%
  T = +50 -15%
- 961 — CAPACITANCE in Microfarads first two digits are significant figures, third digit is number of zeroes to follow: i.e., 961 = 960uf.
- E — OPERATING VOLTAGE at 85°C.

H = 30	M = 90	T= 360	W = 630
J = 50	R = 180	U = 450	
K = 60	S = 270	V = 540	

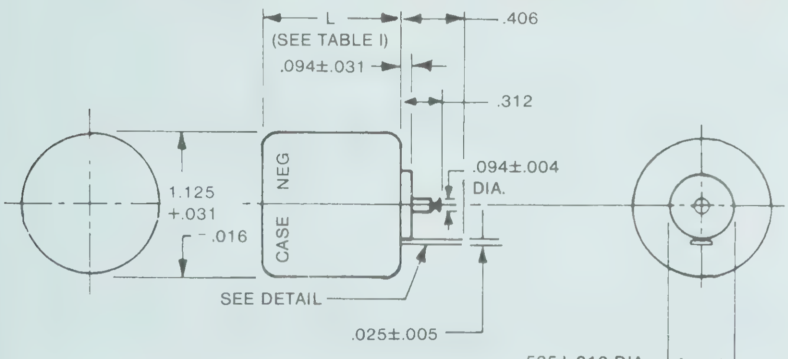
- B — TEMPERATURE CHARACTERISTIC: B = full operating voltage -55° to 85°C and linearly derated to ⅔ rated voltage at 125°C.
- CL17 — STYLE: Fixed non solid electrolyte tantalum capacitor.
  CL17 — stud and lug mount
  CL18 — screw and lug mount

NOTE: Military number does not designate case size. See table for specific capacitance and voltage rating.

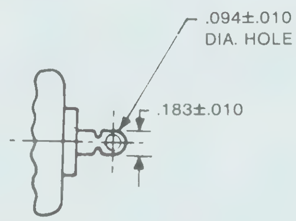
MIL-C-3965/19
STYLES CL17 & CL18

Type Designation 1/	Voltage Rated (+85°C)	Voltage Derated (+125°C)	Voltage Surge (+85°C)	Capacitance	Cap. Tolerance	Dissipation Factor (max.)	DC Leakage (max.) +25°C	DC Leakage (max.) +85°C	DC Leakage (max.) +125°C	Impedance (max.)	Cap. Change (-55°C)	Dimension L ±.062 (1.57)
	volts, dc	volts, dc	volts, dc	uF		%	uA	uA	uA	ohms	%	inches (mm)
CL1-BH371-PG	30	26	34.5	370	M,T	41.0	18	125	180	15	-65	.600(15.24)
CL1-BH651-PG	30	26	34.5	650	M,T	74.0	21	145	210	15	-85	1.100(27.94)
CL1-BH132-PG	30	26	34.5	1300	M,T	148.0	27	190	270	10	-85	1.100(27.94)
CL1-BK201-PG	60	52	69.0	200	M,T	22.5	19	135	190	30	-50	.600(15.24)
CL1-BK351-PG	60	52	69.0	350	M,T	39.8	22	155	220	25	-70	1.100(27.94)
CL1-BK701-PG	60	52	69.0	700	M,T	79.0	29	200	290	15	-70	1.100(27.94)
CL1-BM121-PG	90	78	103.0	120	M,T	13.0	19	135	190	40	-40	.600(15.24)
CL1-BM221-PG	90	78	103.0	220	M,T	24.8	21	145	210	30	-60	1.100(27.94)
CL1-BM451-PG	90	78	103.0	450	M,T	50.2	29	195	290	35	-60	1.100(27.94)
CL1-BR420-PG	180	155	207.0	42	M,T	16.1	17	120	170	75	-40	.976(24.79)
CL1-BR600-PG	180	155	207.0	60	M,T	13.0	19	135	190	60	-40	.976(24.79)
CL1-BR111-PG	180	155	207.0	110	M,T	24.8	21	145	210	60	-60	1.938(49.23)
CL1-BR231-PG	180	155	207.0	230	M,T	52.0	29	200	290	50	-60	1.938(49.23)
CL1-BS280-PG	270	235	310.0	28	M,T	16.1	19	120	190	80	-40	1.350(34.29)
CL1-BS400-PG	270	235	310.0	40	M,T	22.5	19	135	190	100	-40	1.350(34.29)
CL1-BS750-PG	270	235	310.0	75	M,T	24.8	21	145	210	90	-60	2.812(71.42)
CL1-BS151-PG	270	235	310.0	150	M,T	52.0	28	195	280	75	-60	2.812(71.42)
CL1-BT220-PG	360	310	414.0	22	M,T	16.1	18	125	180	100	-40	1.705(43.31)
CL1-BT300-PG	360	310	414.0	30	M,T	22.5	19	135	190	120	-40	1.705(43.31)
CL1-BU170-PG	450	390	518.0	17	M,T	16.1	18	125	180	130	-40	2.080(52.83)
CL1-BU250-PG	450	390	518.0	25	M,T	23.5	19	135	190	150	-40	2.080(52.83)
CL1-BV140-PG	540	470	621.0	14	M,T	16.1	17	120	170	160	-40	2.435(61.85)
CL1-BV200-PG	540	470	621.0	20	M,T	22.5	19	135	190	170	-40	2.435(61.85)
CL1-BW120-PG	630	545	724.0	12	M,T	16.1	17	120	170	180	-40	2.810(71.37)
CL1-BW180-PG	630	545	724.0	18	M,T	23.5	19	135	190	200	-40	2.810(71.37)

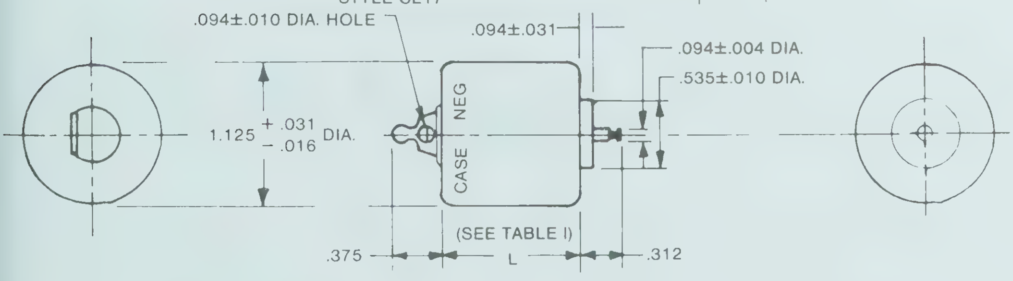
1/ Complete type designation will include additional symbols to indicate style and capacitance tolerance.



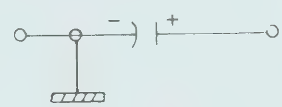
STYLE CL17



DETAIL CL17
SOLDER-LUG TERMINAL



STYLE CL18



CIRCUIT DIAGRAM

MIL-C-3965

Military Style Tantalum Capacitors

MIL-C-3965/21
STYLE CL55

DESIGN AND CONSTRUCTION
Each capacitor consists of an assembly of tubular wet tantalum capacitors potted in a metal case and hermetically sealed with each terminal insulated from the capacitor case.

TERMINALS
Terminals are the solder-lug type.

D.C. LEAKAGE
DCL shall be measured following a rated voltage electrification period not exceeding 5 minutes. The DCL shall not exceed the value shown for each specific rating.

CAPACITANCE
Capacitance shall be determined in accordance with Method 305 of MIL-STD-202 at 120 ±5Hz. The magnitude of the A.C. voltage shall not exceed 1.0 vrms and the D.C. bias shall not exceed 2.2 VDC.

POWER FACTOR
When measured as specified above, the P.F. for capacitors of 5 VDC rating and less shall not exceed 15%, and for ratings of 50 VDC o more shall not exceed 12%.

TEMPERATURE CHARACTERISTICS

	-55°C	+25°C	85°C	125°C
Capacitance	-35% ΔC	±20% of nominal ±5% of retrace	+25% ΔC	+25% ΔC
Power Factor	———	Initial Limits	Initial Limits	Initial Limits
DCL	———	(See Table)	(See Table)	(See Table)
Impedance	(See Table)	———	———	———

LIFE TEST
Following a 2000 hours life test at 85°C and full rated voltage applied:

1. The DCL shall not exceed initial limit
2. The capacitance change shall not exceed ±25%
3. The Power Factor shall not exceed 130% of initial measurement

The above limits also apply following a life test of 2000 hours at 125°C with derated voltage applied.

MILITARY CODING SYSTEM

CL55 B E 961 M P G

- G — SEAL TYPE — G = Hermetic
- P — POLARITY — P = Polar
- M — CAPACITANCE TOLERANCE — M = ±20%
- 961 — CAPACITANCE in Microfarads first two digits are significant figures, third digit is number of zeroes to follow: i.e., 961 = 960 uf.
- E — OPERATING VOLTAGE at 85°C.

E = 15	L = 75
H = 30	N = 100
J = 50	Q = 150

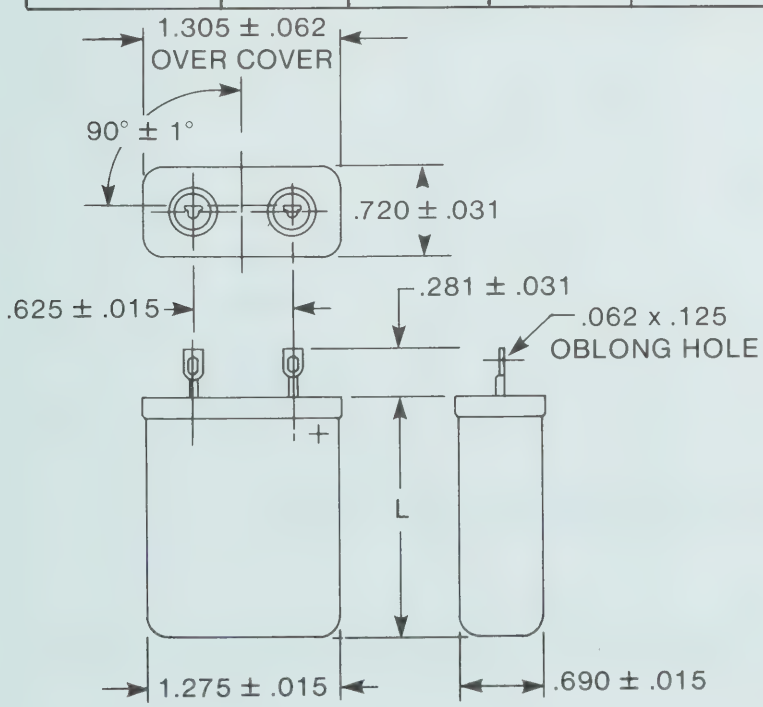
- B — TEMPERATURE CHARACTERISTIC: B = full operating voltage -55°C to 85°C and linearly derated to ⅔ rated voltage at 125°C.
- CL55 — STYLE: Fixed non solid electrolyte tantalum capacitor.

NOTE: Military number does not designate case size. See table for specific capacitance and voltage rating.

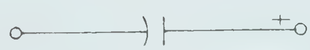
MIL-C-3965
Military Style Tantalum Capacitors

MIL-C-3965/21
STYLE CL55

Type Designation	Voltage Rated (85°C)	Voltage Derated (125°C)	Voltage Surge (85°C)	Capacitance	DC Leakage (max.) 25°C	DC Leakage (max.) 85°C & 125°C	Impedance (max.)	Case Size
	volts, dc	volts, dc	volts, dc	uf	uA	uA	ohms	
CL55BE961MPG	15	10	17.2	960	7	58	3.10	A1
CL55BE122MPG	15	10	17.2	1200	9	72	2.30	A2
CL55BE142MPG	15	10	17.2	1400	11	84	1.70	A3
CL55BE212MPG	15	10	17.2	2100	16	126	1.30	A4
CL55BE242MPG	15	10	17.2	2400	18	144	1.15	A5
CL55BH521MPG	30	20	34.5	520	8	63	5.30	A1
CL55BH661MPG	30	20	34.5	660	10	80	4.20	A2
CL55BH821MPG	30	20	34.5	820	13	99	2.90	A3
CL55BH122MPG	30	20	34.5	1200	18	144	2.30	A4
CL55BH132MPG	30	20	34.5	1300	20	156	2.10	A5
CL55BJ401MPG	50	30	57.5	400	10	80	7.20	A1
CL55BJ431MPG	50	30	57.5	430	10	78	6.40	A1
CL55BJ501MPG	50	30	57.5	500	13	100	5.60	A2
CL55BJ601MPG	50	30	57.5	600	15	120	4.10	A3
CL55BJ801MPG	50	30	57.5	800	20	160	3.10	A4
CL55BJ102MPG	50	30	57.5	1000	23	180	2.80	A5
CL55BL271MPG	75	50	86.2	270	9	81	8.50	A1
CL55BL331MPG	75	50	86.2	330	12	99	7.00	A2
CL55BL401MPG	75	50	86.2	400	15	119	5.00	A3
CL55BL601MPG	75	50	86.2	600	23	180	3.65	A4
CL55BL661MPG	75	50	86.2	660	25	198	3.50	A5
CL55BN171MPG	100	65	115.0	170	9	68	15.00	A1
CL55BN221MPG	100	65	115.0	220	11	88	11.60	A2
CL55BN261MPG	100	65	115.0	260	13	104	8.00	A3
CL55BN351MPG	100	65	115.0	350	18	140	6.50	A4
CL55BN441MPG	100	65	115.0	440	22	176	5.80	A5
CL55BQ700MPG	150	100	172.0	70	6	42	28.80	A1
CL55BQ900MPG	150	100	172.0	90	7	54	22.40	A2
CL55BQ101MPG	150	100	172.0	100	8	60	16.40	A3
CL55BQ141MPG	150	100	172.0	140	11	84	12.40	A4
CL55BQ181MPG	150	100	172.0	180	14	104	11.20	A5



	Dimensions	
	L ± .031(.79)	
	In	mm
A1	1.062	26.97
A2	1.375	34.93
A3	1.625	41.28
A4	2.000	50.80
A5	2.500	63.50



CIRCUIT DIAGRAM

MIL-C-3965

Military Style Tantalum Capacitors

MIL-C-3965/4
STYLES CL64 & CL65

MILITARY CODING SYSTEM

CL65 B J 820 K P E

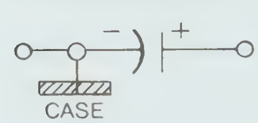
- E — ELASTOMER SEAL
- P — P = Polarized N = Non Polarized (Not available in CL64 or CL65)
- K — CAPACITANCE TOLERANCE
  J = ±5% M = ±20%
  K = ±10%
- 820 — CAPACITANCE, NOMINAL
  Expressed in microfarads. First two digits are significant figures, third digit is number of zeros to follow. Use "R" for decimal point.
  Examples: 1R7 means 1.7 MFD
  330 means 33 MFD
  331 means 330 MFD
- J — RATED VOLTAGE AT 85 C

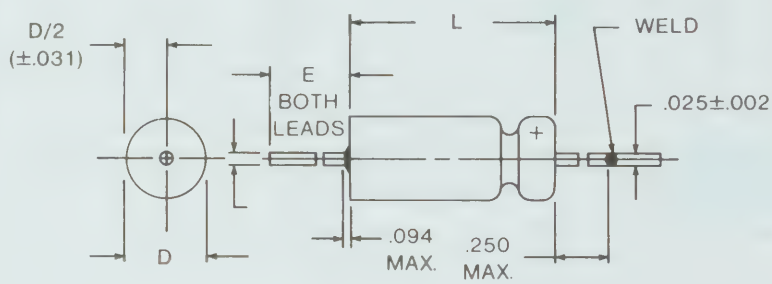
B = 6	E = 15	J = 50	N = 100
C = 8	G = 25	K = 60	P = 125
D = 10	H = 30	L = 75	

- B — CHARACTERISTIC.
  Rated -55°C to +85 C
  Operable to 125°C with derating.
- CL65 — STYLE: Fixed non-solid electrolytic tantalum capacitor.

NOTE: Military number does not designate case size. See table for specific capacitance and voltage rating.

CIRCUIT DIAGRAM





Dimensions

Case Size	L 1/ +.031 (.79) −.016 (.41)	D ±.016 (.41) (CL64)	D Max (CL65)	E ±.250 (6.35)
T1	.453 (11.51)	.188 (4.78)	.219 (5.56)	1.500 (38.10)
T2	.641 (16.28)	.281 (7.14)	.312 (7.92)	2.250 (57.15)
T3	.766 (19.46)	.375 (9.53)	.406 (10.31)	2.250 (57.15)

1/ For Style CL65, nonshrinkable sleeving shall extend .016 inch minimum, 0.62 inch maximum, beyond each end of the case; shrinkable sleeving shall lap over the ends of case.

NOTES:
1. All dimensions in inches.
2. Millimeters are in parentheses.
3. Metric equivalents (to the nearest .01 mm) are given for general information and are based upon 1 inch =25.4 mm.
4. The weld shall not be enclosed in the end seal.

MIL-C-3965/4
STYLES CL64 & CL65

Type designation 1/	Rated (+85°C)	Voltage Derated (+125°C)	Surge (+85°C)	Capacitance 2/	Cap. tolerance	DC leakage (max.) +25°C	DC leakage (max.) +85°C & +125°C	Power factor (max.)	Impedance (max.)	Capacitance change -55°C	Capacitance change +85°C	Capacitance change +125°C	Case size
	volts, dc	volts, dc	volts, dc	uf		ua	ua	percent	ohms	percent	percent	percent	
CL6-BB300-PE	6	4	6.9	30.0	J, K, M,	1	2	9 1	100	-40	+10.5	+12	T1
CL6-BB680-PE	6	4	6.9	68 0*	J, K, M	1	2	20 0	60	-40	+14	+16	T1
CL6-BB141-PE	6	4	6 9	140.0	J, K, M	1	3	20.8	40	-40	+14	+16	T2
CL6-BB271-PE	6	4	6.9	270.0*	J, K, M	1	7	63.3	25	-44	+17.5	+20	T2
CL6-BB331-PE	6	4	6.9	330.0	J, K, M	2	8	44.4	20	-44	+14	+16	T3
CL6-BB561-PE	6	4	6.9	560.0*	J, K, M	2	13	78.8	25	-64	+17 5	+20	T3
CL6-BC250-PE	8	5	9.2	25.0	J, K, M	1	2	7.6	100	-40	+10.5	+12	T1
CL6-BC560-PE	8	5	9.2	56.0*	J, K, M	1	2	16.8	59	-40	+14	+16	T1
CL6-BC221-PE	8	5	9.2	220.0*	J, K, M	1	7	55.3	30	-44	+17.5	+20	T2
CL6-BC431-PE	8	5	9 2	430.0*	J, K, M	2	14	67.5	25	-64	+17 5	+20	T3
CL6-BD200-PE	10	7	11.5	20.0	J, K, M	1	2	6.1	175	-32	+10.5	+12	T1
CL6-BD470-PE	10	7	11.5	47 0*	J, K, M	1	2	17.8	100	-36	+14	+16	T1
CL6-BD101-PE	10	7	11.5	100 0	J, K, M	1	4	15.0	60	-36	+14	+16	T2
CL6-BD181-PE	10	7	11.5	180 0*	J, K, M	1	7	47.8	40	-36	+14	+16	T2
CL6-BD251-PE	10	7	11 5	250.0	J, K, M	2	10	35.4	30	-40	+14	+16	T3
CL6-BD391-PE	10	7	11.5	390.0*	J, K, M	2	16	65.9	25	-64	+17.5	+20	T3
CL6-BE150-PE	15	10	17.2	15.0	J, K, M	1	2	5.7	155	-24	+10.5	+12	T1
CL6-BE330-PE	15	10	17.2	33.0*	J, K, M	1	2	12.4	90	-28	+14	+16	T1
CL6-BE700-PE	15	10	17.2	70.0	J, K, M	1	4	13.0	75	-28	+14	+16	T2
CL6-BE121-PE	15	10	17.2	120.0*	J, K, M	1	7	34.5	50	-28	+17.5	+20	T2
CL6-BE171-PE	15	10	17.2	170.0	J, K, M	2	10	24.6	35	-32	+14	+16	T3
CL6-BE271-PE	15	10	17 2	270.0*	J, K, M	2	16	52.0	30	-56	+17.5	+20	T3
CL6-BG100-PE	25	15	28.8	10 0	J, K, M	1	2	4.6	220	-16	+8	+9	T1
CL6-BG220-PE	25	15	28.8	22.0*	J, K, M	1	2	8.3	140	-20	+10.5	+12	T1
CL6-BG101-PE	25	15	28.8	100.0*	J, K, M	1	10	30.0	50	-28	+13	+15	T2
CL6-BG181-PE	25	15	28.8	180.0*	J, K, M	2	18	47.7	32	-48	+13	+15	T3
CL6-BH080-PE	30	20	34.5	8.0	J, K, M	1	2	4.5	275	-16	+8	+12	T1
CL6-BH150-PE	30	20	34 5	15.0*	J, K, M	1	2	9.1	175	-20	+10.5	+12	T1
CL6-BH400-PE	30	20	34 5	40.0	J, K, M	1	5	12 1	65	-24	+10.5	+12	T2
CL6-BH680-PE	30	20	34 5	68.0*	J, K, M	1	8	29.6	60	-24	+13	+15	T2
CL6-BH101-PE	30	20	34.5	100.0	J, K, M	2	12	18.6	40	-28	+10.5	+12	T3
CL6-BH151-PE	30	20	34.5	150.0*	J, K, M	2	18	41.5	35	-48	+13	+15	T3
CL6-BJ050-PE	50	30	57.5	5 0	J, K, M	1	2	3.4	400	-16	+5	+6	T1
CL6-BJ100-PE	50	30	57.5	10.0*	J, K, M	1	2	6.0	250	-24	+8	+9	T1
CL6-BJ250-PE	50	30	57.5	25 0	J, K, M	1	5	11.1	95	-20	+10.5	+12	T2
CL6-BJ470-PE	50	30	57.5	47.0*	J, K, M	1	9	20.9	70	-28	+13	+15	T2
CL6-BJ600-PE	50	30	57.5	60.0	J, K, M	2	12	13.5	45	-16	+10.5	+12	T3
CL6-BJ820-PE	50	30	57.5	82.0*	J, K, M	2	16	24 2	45	-32	+13	+15	T3
CL6-BK040-PE	60	40	69.0	4.0	J, K, M	1	2	3.0	550	-16	+5	+6	T1
CL6-BK8R2-PE	60	40	69.0	8.2*	J, K, M	1	2	5.0	275	-24	+8	+9	T1
CL6-BK200-PE	60	40	69.0	20.0	J, K, M	1	5	7.6	105	-16	+10.5	+12	T2
CL6-BK390-PE	60	40	69.0	39.0*	J, K, M	1	9	20.3	90	-28	+10.5	+12	T2
CL6-BK500-PE	60	40	69.0	50.0	J, K, M	2	12	15.1	50	-16	+10.5	+12	T3
CL6-BK680-PE	60	40	69.0	68.0*	J, K, M	2	16	29.3	50	-32	+10.5	+12	T3
CL6-BL3R5-PE	75	50	86.2	3.5	J, K, M	1	2	2.5	650	-16	+5	+6	T1
CL6-BL6R8-PE	75	50	86.2	6.8*	J, K, M	1	2	4.1	300	-20	+8	+9	T1
CL6-BL150-PE	75	50	86.2	15.0	J, K, M	1	5	7.5	150	-16	+8	+9	T2
CL6-BL330-PE	75	50	86.2	33.0*	J, K, M	1	10	17.2	90	-24	+10.5	+15	T2
CL6-BL400-PE	75	50	86.2	40.0	J, K, M	2	12	15.0	60	-16	+10.5	+12	T3
CL6-BL560-PE	75	50	86.2	56.0*	J, K, M	2	17	24.9	60	-28	+10 5	+15	T3
CL6-BN2R5-PE	100	65	115.0	2.5	J, K, M	1	2	1.9	950	-16	+7	+8	T1
CL6-BN4R7-PE	100	65	115.0	4.7*	J, K, M	1	2	3.6	500	-16	+7	+8	T1
CL6-BN110-PE	100	65	115.0	11.0	J, K, M	1	4	5.0	200	-16	+7	+8	T2
CL6-BN220-PE	100	65	115.0	22.0*	J, K, M	1	9	11.7	100	-16	+7	+8	T2
CL6-BN300-PE	100	65	115.0	30.0	J, K, M	2	12	9.1	80	-16	+7	+8	T3
CL6-BN430-PE	100	65	115.0	43.0*	J, K, M	2	17	19.3	70	-20	+7	+8	T3
CL6-BP1R7-PE	125	85	144 0	1.7	J, K, M	1	2	1.9	1,250	-16	+7	+8	T1
CL6-BP3R6-PE	125	85	144.0	3.6*	J, K, M	1	2	4.1	600	-16	+7	+8	T1
CL6-BP090-PE	125	85	144.0	9.0	J, K, M	1	5	10.2	240	-16	+7	+8	T2
CL6-BP140-PE	125	85	144.0.	14.0*	J, K, M	1	7	12.6	167	-16	+7	+8	T2
CL6-BP250-PE	125	85	144.0	25.0*	J, K, M	2	13	18.7	93	-16	+7	+8	T3

1/ Complete type designation will include additional symbols to indicate style and capacitance tolerance.
2/ The asterick (*) indicates high-capacitance series.

MIL-C-3965
Military Style Tantalum Capacitors

MIL-C-3965/24
STYLES CL66 & CL67

MILITARY CODING SYSTEM

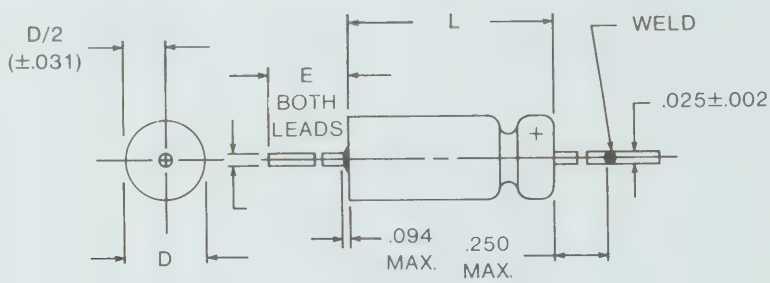
CL66 B J 820 K P G

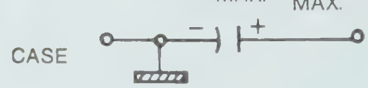
- G — GLASS TO METAL HERMETIC SEAL
- P — P = Polarized N = Non Polarized (Not available in CL66 or CL67)
- K — CAPACITANCE TOLERANCE
  J = ±5% M = ±20%
  K = ±10%
- 820 — CAPACITANCE, NOMINAL
  Expressed in microfarads. First two digits are significant figures, third digit is number of zeros to follow. Use "R" for decimal point. Examples: 1R7 means 1.7 MFD
  330 means 33 MFD
  331 means 330 MFD
- J — RATED VOLTAGE AT 85°C

B = 6	E = 15	J = 50	N = 100
C = 8	G = 25	K = 60	P = 125
D = 10	H = 30	L = 75	

- B — CHARACTERISTIC:
  Rated -55°C to +85°C
  Operable to 125°C with derating.
- CL66 — STYLE
  CL66 uninsulated
  CL67 insulated.

NOTE: *Military number does not designate case size. See table for specific capacitance and voltage rating.*





CIRCUIT DIAGRAM

Case Size	DIMENSIONS — INCHES (mm)			
	L [1]	D		E
	+.031(.79) −.016(.41)	±.016(.41) (CL66)	Max. (CL67)	±.250(6.35)
T1	.453(11.51)	.188(4.78)	.219(5.56)	1.500(38.10)
T2	.641(16.28)	.281(7.14)	.312(7.92)	2.250(57.15)
T3	.766(19.46)	.375(9.53)	.406(10.31)	2.250(57.15)

1/ For style CL67, nonshrinkable sleeving shall extend .016 inch minimum, .062 inch maximum, beyond each end of the case; shrinkable sleeving shall lap over the ends of the case.

MIL-C-3965/24
STYLES CL66 & CL67

Type designation 1/	Voltage Rated (+85°C)	Voltage Derated (+125°C)	Voltage Surge (+85°C)	Capacitance 2/	Cap. tolerance	DC leakage (max.) +25°C	DC leakage (max.) +85°C & +125°C	Dissipation factor (max.)	Impedance (max.)	Capacitance change -55°C	Capacitance change +85°C	Capacitance change +125°C	Case size
	volts, dc	volts, dc	volts, dc	uF		uA	uA	percent	ohms	percent	percent	percent	
CL6-BB300-PG	6	4	6.9	30.0	J, K, M,	1	2	9.1	100	-40	+10.5	+12	T1
CL6-BB680-PG	6	4	6.9	68.0*	J, K, M	1	2	20.4	60	-40	+14	+16	T1
CL6-BB141-PG	6	4	6.9	140.0	J, K, M	1	3	21.3	40	-40	+14	+16	T2
CL6-BB271-PG	6	4	6.9	270.0*	J, K, M	1	7	81.8	25	-44	+17.5	+20	T2
CL6-BB331-PG	6	4	6.9	330.0	J, K, M	2	8	49.6	20	-44	+14	+16	T3
CL6-BB561-PG	6	4	6.9	560.0*	J, K, M	2	13	128.0	25	-64	+17.5	+20	T3
CL6-BC250-PG	8	5	9.2	25.0	J, K, M	1	2	7.6	100	-40	+10.5	+12	T1
CL6-BC560-PG	8	5	9.2	56.0*	J, K, M	1	2	17.0	59	-40	+14	+16	T1
CL6-BC221-PG	8	5	9.2	220.0*	J, K, M	1	7	66.4	30	-44	+17.5	+20	T2
CL6-BC431-PG	8	5	9.2	430.0*	J, K, M	2	14	91.5	25	-64	+17.5	+20	T3
CL6-BD200-PG	10	7	11.5	20.0	J, K, M	1	2	6.1	175	-32	+10.5	+12	T1
CL6-BD470-PG	10	7	11.5	47.0*	J, K, M	1	2	18.1	100	-36	+14	+16	T1
CL6-BD101-PG	10	7	11.5	100.0	J, K, M	1	4	15.2	60	-36	+14	+16	T2
CL6-BD181-PG	10	7	11.5	180.0*	J, K, M	1	7	54.4	40	-36	+14	+16	T2
CL6-BD251-PG	10	7	11.5	250.0	J, K, M	2	10	37.8	30	-40	+14	+16	T3
CL6-BD391-PG	10	7	11.5	390.0*	J, K, M	2	16	87.6	25	-64	+17.5	+20	T3
CL6-BE150-PG	15	10	17.2	15.0	J, K, M	1	2	5.7	155	-24	+10.5	+12	T1
CL6-BE330-PG	15	10	17.2	33.0*	J, K, M	1	2	12.5	90	-28	+14	+16	T1
CL6-BE700-PG	15	10	17.2	70.0	J, K, M	1	4	13.1	75	-28	+14	+16	T2
CL6-BE121-PG	15	10	17.2	120.0*	J, K, M	1	7	36.8	50	-28	+17.5	+20	T2
CL6-BE171-PG	15	10	17.2	170.0	J, K, M	2	10	25.4	35	-32	+14	+16	T3
CL6-BE271-PG	15	10	17.2	270.0*	J, K, M	2	16	60.9	30	-56	+17.5	+20	T3
CL6-BG100-PG	25	15	28.8	10.0	J, K, M	1	2	4.6	220	-16	+8	+9	T1
CL6-BG220-PG	25	15	28.8	22.0*	J, K, M	1	2	8.3	140	-20	+10.5	+12	T1
CL6-BG101-PG	25	15	28.8	100.0*	J, K, M	1	10	31.4	50	-28	+13	+15	T2
CL6-BG181-PG	25	15	28.8	180.0*	J, K, M	2	18	54.3	32	-48	+13	+15	T3
CL6-BH080-PG	30	20	34.5	8.0	J, K, M	1	2	4.5	275	-16	+8	+12	T1
CL6-BH150-PG	30	20	34.5	15.0*	J, K, M	1	2	9.1	175	-20	+10.5	+12	T1
CL6-BH400-PG	30	20	34.5	40.0	J, K, M	1	5	12.2	65	-24	+10.5	+12	T2
CL6-BH680-PG	30	20	34.5	68.0*	J, K, M	1	8	31.0	60	-24	+13	+15	T2
CL6-BH101-PG	30	20	34.5	100.0	J, K, M	2	12	19.0	40	-28	+10.5	+12	T3
CL6-BH151-PG	30	20	34.5	150.0*	J, K, M	2	18	46.0	35	-48	+13	+15	T3
CL6-BJ050-PG	50	30	57.5	5.0	J, K, M	1	2	3.4	400	-16	+5	+6	T1
CL6-BJ100-PG	50	30	57.5	10.0*	J, K, M	1	2	6.0	250	-24	+8	+9	T1
CL6-BJ250-PG	50	30	57.5	25.0	J, K, M	1	5	11.2	95	-20	+10.5	+12	T2
CL6-BJ470-PG	50	30	57.5	47.0*	J, K, M	1	9	21.4	70	-28	+13	+15	T2
CL6-BJ600-PG	50	30	57.5	60.0	J, K, M	2	12	13.6	45	-16	+10.5	+12	T3
CL6-BJ820-PG	50	30	57.5	82.0*	J, K, M	2	16	24.9	45	-32	+13	+15	T3
CL6-BK040-PG	60	40	69.0	4.0	J, K, M	1	2	3.0	550	-16	+5	+6	T1
CL6-BK8R2-PG	60	40	69.0	8.2*	J, K, M	1	2	5.0	275	-24	+8	+9	T1
CL6-BK200-PG	60	40	69.0	20.0	J, K, M	1	5	7.6	105	-16	+10.5	+12	T2
CL6-BK390-PG	60	40	69.0	39.0*	J, K, M	1	9	20.7	90	-28	+10.5	+12	T2
CL6-BK500-PG	60	40	69.0	50.0	J, K, M	2	12	15.3	50	-16	+10.5	+12	T3
CL6-BK680-PG	60	40	69.0	68.0*	J, K, M	2	16	20.7	50	-32	+10.5	+12	T3
CL6-BL3R5-PG	75	50	86.2	3.5	J, K, M	1	2	2.5	650	-16	+5	+6	T1
CL6-BL6R8-PG	75	50	86.2	6.8*	J, K, M	1	2	4.1	300	-20	+8	+9	T1
CL6-BL150-PG	75	50	86.2	15.0	J, K, M	1	5	7.5	150	-16	+8	+9	T2
CL6-BL330-PG	75	50	86.2	33.0*	J, K, M	1	10	17.5	90	-24	+10.5	+15	T2
CL6-BL400-PG	75	50	86.2	40.0	J, K, M	2	12	15.2	60	-16	+10.5	+12	T3
CL6-BL560-PG	75	50	86.2	56.0*	J, K, M	2	17	26.0	60	-28	+10.5	+15	T3
CL6-BN2R5-PG	100	65	115.0	2.5	J, K, M	1	2	5.0	950	-16	+7	+8	T1
CL6-BN4R7-PG	100	65	115.0	4.7*	J, K, M	1	2	3.6	500	-16	+7	+8	T1
CL6-BN110-PG	100	65	115.0	11.0	J, K, M	1	4	5.0	200	-16	+7	+8	T2
CL6-BN220-PG	100	65	115.0	22.0*	J, K, M	1	9	11.8	100	-16	+7	+8	T2
CL6-BN300-PG	100	65	115.0	30.0	J, K, M	2	12	9.1	80	-16	+7	+8	T3
CL6-BN430-PG	100	65	115.0	43.0*	J, K, M	2	17	19.7	70	-20	+7	+8	T3
CL6-BP1R7-PG	125	85	144.0	1.7	J, K, M	1	2	7.0	1,250	-16	+7	+8	T1
CL6-BP3R6-PG	125	85	144.0	3.6*	J, K, M	1	2	4.1	600	-16	+7	+8	T1
CL6-BP090-PG	125	85	144.0	9.0	J, K, M	1	5	10.2	240	-16	+7	+8	T2
CL6-BP140-PG	125	85	144.0	14.0*	J, K, M	1	7	12.7	167	-16	+7	+8	T2
CL6-BP250-PG	125	85	144.0	25.0*	J, K, M	2	13	19.0	93	-16	+7	+8	T3

1/ *Complete type designation will include additional symbols to indicate style and capacitance tolerance.*
2/ *The asterick (*) indicates high-capacitance series.*

MIL-C-39006

Military Style Tantalum Capacitors

MIL-C-39006

DESIGN AND CONSTRUCTION

Each fixed capacitor consists of a sintered tantalum anode isolated by an electrolytically formed oxide dielectric, and a thixotropic non solid electrolyte cathode, enclosed in a tubular fine grade silver metal case and integrally sealed.

CASE INSULATION

Insulating sleeving is of nonfungus nutrient material and will not shrink, creep, or soften so as to expose the cylindrical portion of the case following any of the tests described herein. The dielectric strength of the insulating material shall not be less than 2000 volts and the insulation resistance shall not be less than 100 megohms.

LEADS

Leads are of solid conductor type of length and diameter described in tables. The anode lead is of N5 type to MIL-STD-1276, and cathode lead is of C5 copper.

Each lead shall withstand 4 bends, and one 3 pound lead pull without loosening, breaking or showing other permanent damage. One bend will consist of rotating the capacitor body 90° from vertical to horizontal and return while the lead is firmly held within .313 inches of the body.

DC LEAKAGE

DCL shall be measured following a rated voltage electrification period not exceeding 5 minutes.

CAPACITANCE

Capacitance shall be determined in accordance with Method 305 of MIL-STD-202 at 120 ±5Hz. The magnitude of the A.C. voltage shall not exceed 1.0V RMS and the bias shall not exceed 2.2V DC.

DISSIPATION FACTOR

Shall be determined by a polarized bridge.

IMPEDANCE

The capacitor shall be conditioned at $-55°C\ ^{+0°C}_{-3°C}$ for a period of not less than 30 minutes or until stable measurements can be obtained. The impedance shall then be measured directly or determined from measurements obtained on a bridge. Measurements shall be made at 120 ±5Hz. Measurement accuracy shall be within ±5 percent.

SHOCK, MEDIUM IMPACT

Capacitors shall be tested in accordance with method 213, condition of MIL-STD-202. The following details and exceptions shall apply.

(a) Special mounting means: Capacitors with axial-wire lead terminals shall be rigidly mounted on a mounting fixture to the body with their terminals secured to rigidly supported stud-terminals, so spaced that the length of each terminal from the capacitor is approximately .375 inch when measured from the edge of the supporting stud-terminal. Capacitor terminals shall be within 30 degrees of being parallel. When securing capacitor terminals, care shall be taken to avoid pinching the capacitor terminals.

(b) Test-condition letter — I (Sawtooth)

(c) Measurements and electrical loading during shock: DC rated voltage shall be applied to the capacitor during test. Observations shall be made to determine intermittent contact or arcing or open- or short-circuiting. Detecting equipment shall be sufficiently sensitive to detect any interruption of 0.5 ms or greater duration.

When capacitors are tested as specified, there shall be no intermittent contacts of 0.5 millisecond (ms) or greater duration, or arcing or any other indication of breakdown, nor shall there by any open- or short-circuiting, mechanical damage, or leakage of electrolyte.

VIBRATION, HIGH FREQUENCY

Capacitors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

(a) Mounting of specimens: The body of the capacitor shall be rigidly mounted to the vibration-test apparatus.

(b) Test-condition letter — B (15G). The motion shall be applied for a total of 8 hours (4 hours in each of two mutually perpendicular directions, one parallel to and the other perpendicular to the cylindrical axis).

(c) Measurements: During the last 30 minutes of vibration in each direction, an electrical measurement shall be made on the capacitors to determine intermittent contacts or open- or short-circuiting. Detecting equipment shall be sufficiently sensitive to detect any interruption of 0.5 ms or greater duration.

(d) Capacitors must also meet the end point electrical requirements specified, and when devices are tested as specified, there shall be no intermittent contacts of 0.5 ms or greater duration, open- or short-circuiting, mechanical damage, or leakage of electrolyte.

SALT SPRAY (Corrosion)

Capacitors shall be tested in accordance with method 101 of MIL-STD-202. The following details and exception shall apply.

(a) Applicable salt solution — 5 percent.
(b) Test-condition letter — B (48 hours).
(c) Measurements after test — Not applicable.

When capacitors are tested as specified, there shall be no harmful corrosion, and at least 90 percent of any exposed metal surface of the capacitor shall be protected by the finish. There shall be no unwrapping of, or mechanical damage to the insulation sleeving, when applicable. Marking shall remain legible.

NOTE: Harmful corrosion shall be construed as being any type of corrosion which in any way interferes with the mechanical or electrical performance of the capacitor.

THERMAL SHOCK

THERMAL SHOCK: Capacitors shall be tested in accordance with method 107 of MIL-STD-202. The following details and exception shall apply:

(a) Conditioning prior to first cycle — 15 minutes at room ambient conditions.

(b) Test condition letter — A, except $125°C\ ^{+4}_{-0}\ C$ and 30 cycles.

(c) Measurements before and after cycling — Not applicable.

SURGE VOLTAGE

Capacitors shall be subjected to 1,000 cycles of the applicable surge voltage. The ambient temperature during cycling shall be 85°C. Each cycle shall consist of a 30-second surge voltage application followed by a 5½-minute discharge period. Voltage application shall be made through a resistance of 1,000 ±100 ohms including the source in series with the capacitor and the voltage source. Each surge voltage cycle shall be performed in such a manner that the capacitor is discharged through the 1,000-ohm resistor at the end of the 30-second application. The test shall be terminated on the discharge portion of the cycle. During the test, an electrical measurement shall be made to detect intermittent contacts and open- and short-circuiting. After the test, capacitors shall be visually examined for mechanical damage and leakage of electrolyte.

When capacitors are tested as specified, there shall be no intermittent contacts, open- or short-circuiting, mechanical damage, or leakage of electrolyte.

MOISTURE RESISTANCE

Capacitors shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

(a) Mounting — Except during examination and measurements, capacitors shall be securely fastened by normal mounting means.
(b) Polarization and loading voltages — 6 volts dc.
(c) Step 7b — Vibration is not required during step 7b.
(d) Final measurements — After the final cycle and within 2 to 6 hours after removal of the capacitors from the humidity chamber, the dc leakage, capacitance, and power factor shall be measured as specified at the initial inspection conditions.

When tested as specified, capacitors shall meet the following requirements:

DC leakage — Shall not exceed 125 percent of the applicable value specified.
Capacitance — Shall change not more than ±8% from the initial measured value.
Power factor — Shall not exceed 115 percent of the applicable value specified.
Visual examination — There shall be no evidence of harmful corrosion, mechanical damage, obliteration of marking, or leakage of electrolyte.

STABILITY AT LOW AND HIGH TEMPERATURES

The measurements specified shall be made in the order shown. The capacitors shall be brought to thermal stability. Thermal stability will have been reached when no further change in capacitance is observed between two successive measurements taken at 15-minute intervals.

When tested as specified, capacitors shall meet the following requirements:

Step 1 (+25°C):
DC leakage — shall not exceed the applicable value specified.
Capacitance — Shall be within the applicable tolerance specified.
Power factor — Shall not exceed the applicable value specified.

Step 2 (-55°C):
Impedance — Shall not exceed the applicable value specified.
Capacitance — Shall change not more than the percent specified from the step 1 measured value.

Step 3 (+25°C):
DC leakage — shall not exceed the applicable value specified.
Capacitance — Shall change not more than ±5% from the step 1 measured value.
Power factor — Shall not exceed the applicable value specified.

Step 4 (+85°C):
DC leakage — Shall not exceed the applicable value specified.
Capacitance — Shall change not more than the percent specified from the step 1 measured value.
Power factor — Shall not exceed the applicable value specified.

Step 5 (+125°C):
DC leakage — Shall not exceed the applicable value specified.
Capacitance — Shall change not more than the percent specified from the step 1 measured value.
Power factor — Shall not exceed the applicable value specified.

Step 6 (+25°C):
DC leakage — Shall not exceed the applicable value specified.
Capacitance — Shall change not more than ±5% from the step 1 measured value.
Power factor — Shall not exceed the applicable value specified.

LIFE TEST

Capacitors shall be tested in accordance with method 108 of MIL-STD-202. The following details and exceptions shall apply.

(a) Distance of temperature measurements from specimens, in inches — Not applicable.
(b) Method of mounting — Capacitors shall be mounted by their terminals.
(c) Test temperature and tolerance — $85^{\circ}\,{}^{+3^{\circ}C}_{-0^{\circ}}$ C.
(d) Operating conditions — DC rated voltage shall be applied gradually (not to exceed 5 minutes either by a slow build-up of the voltage or through a resistor which shall be shorted out within 5 minutes). Voltage shall be applied continuously except for measurement periods. The impedance of the voltage source, as seen from the terminals of each capacitor, shall not exceed 10 ohms. Storage batteries, or an electronic power supply, capable of supplying at least 100 milliampers when a capacitor is shorted out shall be used. For nonpolarized capacitors, the voltage shall be reversed every 125 ± 10 hours.
(e) Test-condition letter — F (2,000 ${}^{+72}_{-0}$ hours).
(f) Measurements during exposure (at 85°C) — DC leakageshall be measured as specified at 0; 240 ${}^{+48}_{-0}$; 1000 ${}^{+48}_{-0}$; and 2,000 ${}^{+72}_{-0}$ hours.
(g) Measurements after exposure — Capacitors shall be returned to the inspection conditions specified and dc leakage, capacitance and power factor shall be measured as specified.
(h) Examination after test — Capacitors shall be visually examined for damage, obliteration of marking, and leakage of electrolyte.

AFTER 2000 HOURS

DC leakage (at 85°C and 25°C) — Shall not exceed the applicable value specified.
Capacitance — Shall change not more than ±10% from the initial measured value.
Dissipation factor — Shall not exceed the applicable value specified.
Visual examination — There shall be no damage, obliteration of marking, or leakage of electrolyte.

AFTER 10,000 HOURS

Except as specified in the following, capacitors shall be tested as specified above.

(a) Test duration shall be 10,000 ${}^{+96}_{-0}$ hours.
(b) DC leakage shall be measured during exposure at 0; 240 ${}^{+48}_{-0}$; 1,000 ${}^{+48}_{-0}$; 2,000 ${}^{+72}_{-0}$; and every 2,000 ${}^{+72}_{-0}$ hours thereafter until 10,000 ${}^{+96}_{-0}$ hours have elapsed. In addition, insulated capacitors shall be tested for dielectric withstanding voltage and insulation resistance.

When tested as specified above, capacitors shall meet the following requirements:

DC leakage (at 85°C) — Shall not exceed 125 percent of the applicable value specified.
DC leakage (at 25°C) — Shall not exceed the applicable value specified.
Capacitance — Shall change not more than +10. -60% from the initial measured value.
Dissipation factor — Shall not exceed 200% of the applicable value specified.
Dielectric withstanding voltage and insulation resistance (insulated capacitors only) — Shall meet the requirements specified.
Visual examination — There shall be no damage, obliteration of marking, or leakage of electrolyte.

MIL-C-39006

Military Style Tantalum Capacitors

MIL-C-39006

For Quality Conformance capacitors shall be tested as specified and the following requirements apply:

DC leakage (at 85°C and 25°C) — Shall not exceed the applicable value specified.

Capacitance — Shall change not more than ±10 percent from the initial measured value.

Dissipation factor — Shall not exceed the applicable value specified.

Visual examination — There shall be no damage, obliteration of marking, or leakage of electrolyte.

QUALITY CONFORMANCE INSPECTION

For quality conformance inspection capacitors shall be Group B tested as shown in the table below, on an inspection lot sampling basis: (Group C environmentals are also a requirement.)

Test	Requirement paragraph	Test paragraph	Sample selection (all FR levels)
Subgroup 1			
Stability at low and high temperatures	3.22	4.7.18	1.5% AQL 10.0% LQ
			No. of sample units to be inspected (all FR levels)
Subgroup 2			
Thermal shock	3.13	4.7.9	20 3/
Life (10,000-hour @ 85°C) 1/	3.24.2	4.7.20.2	10
Life (10,000-hour @ 125°C) 1/	3.27.1	4.7.23.1	10 2/

1/ Only unit hours generated at 85 C shall be used for FR level computation
2/ One failure (maximum) permitted per 80,000 unit hours
3/ Twenty samples minimum; reject criteria shall be 0.65% AQL and 11.0% LQ."

NOTE: Parts undergoing above referenced testing will not be shipped as standard product.

MIL-C-39006/18
STYLE CLR10

CAPACITORS, FIXED, ELECTROLYTIC (NONSOLID ELECTROLYTE), TANTALUM, (POLARIZED, SINTERED SLUG), 85°C (VOLTAGE DERATED TO 125 C), ESTABLISHED RELIABILITY.

MILITARY CODING SYSTEM

M39006 / 18 - 1000

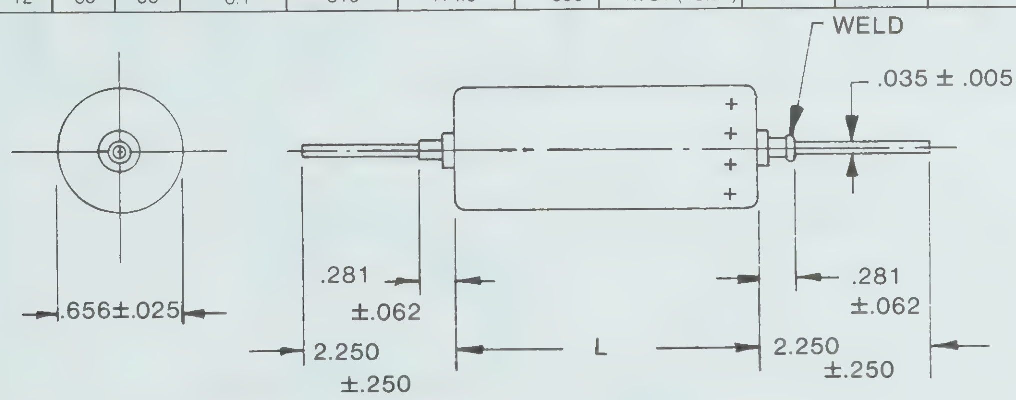
- 1000 — DASH NUMBER FROM TABLE. For specific value of Capacitance, Capacitance Tolerance, Voltage, Fuse Size, and Failure Rate Level the table must be consulted.
- 18 — DETAIL SHEET FOR APPLICABLE STYLE /18 is CLR10.
- M39006 — MIL-C-39006–Generic specification for established reliability non-solid electrolyte tantalum capacitors.

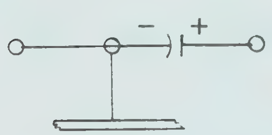
3

Tantalum Capacitors

Capacitor characteristics

RATED VOLTAGE (85°C)	CAP.	DC LEAKAGE (Max.) 25°C	DC LEAKAGE (Max.) 85°C	DC LEAKAGE (Max.) 125°C	DISSIPATION FACTOR (max.)	DERATED VOLTAGE (125°C)	SURGE VOLTAGE (85°C)	IMPEDANCE (max.)	DIMENSION L ±.062 (1.57)	PART NO. M39006/18 FAILURE RATE LEVEL (%/1,000 Hr.) L(2.0)	M(1.0)	P(0.1)	R(0.01)	S(0.001)
volts, dc	uF	uA	uA	uA	percent	volts, dc	volts, dc	ohms	inches (mm)					
8	70.0	6	30	48	47	7	9.2	60	.438 (11.13)	1000	1018	1036	1054	1072
8	140.0	10	50	80	47	7	9.2	30	.562 (14.27)	1001	1019	1037	1055	1073
10	50.0	5	25	40	35	9	11.5	75	.438 (11.13)	1002	1020	1038	1056	1074
10	100.0	9	45	72	35	9	11.5	40	.562 (14.27)	1003	1021	1039	1057	1075
20	28.0	6	30	48	21	18	23.0	85	.438 (11.13)	1004	1022	1040	1058	1076
20	56.0	10	50	80	21	18	23.0	45	.562 (14.27)	1005	1023	1041	1059	1077
30	20.0	7	35	56	15	26	34.5	125	.438 (11.13)	1006	1024	1042	1060	1078
30	40.0	12	60	96	15	26	34.5	75	.562 (14.27)	1007	1025	1043	1061	1079
60	12.0	7	35	56	9.1	52	69.0	180	.438 (11.13)	1008	1026	1044	1062	1080
60	25.0	12	60	96	9.6	52	69.0	90	.562 (14.27)	1009	1027	1045	1063	1081
90	8.0	7	35	56	6.1	78	103.0	250	.438 (11.13)	1010	1028	1046	1064	1082
90	16.0	12	60	96	6.1	78	103.0	125	.562 (14.27)	1011	1029	1047	1065	1083
180	4.0	7	35	56	6.1	155	207.0	500	.719 (18.26)	1012	1030	1048	1066	1084
180	8.0	12	60	96	6.1	155	207.0	250	.938 (23.83)	1013	1031	1049	1067	1085
270	2.5	7	35	56	5.7	235	310.0	750	1.031 (26.19)	1014	1032	1050	1068	1086
270	5.0	11	55	88	5.7	235	310.0	375	1,375 (34.93)	1015	1033	1051	1069	1087
360	2.0	7	35	56	6.1	310	414.0	1000	1.312 (33.32)	1016	1034	1052	1070	1088
360	4.0	12	60	96	6.1	310	414.0	500	1.781 (45.24)	1017	1035	1053	1071	1089





CASE
CIRCUIT DIAGRAM

MIL-C-39006

Military Style Tantalum Capacitors

MIL-C-39006/19
STYLE CLR14

CAPACITORS, FIXED, ELECTROLYTIC (NONSOLID ELECTROLYTE), TANTALUM, (POLARIZED, SINTERED SLUG), 85°C (VOLTAGE DERATED TO 125°C), ESTABLISHED RELIABILITY.

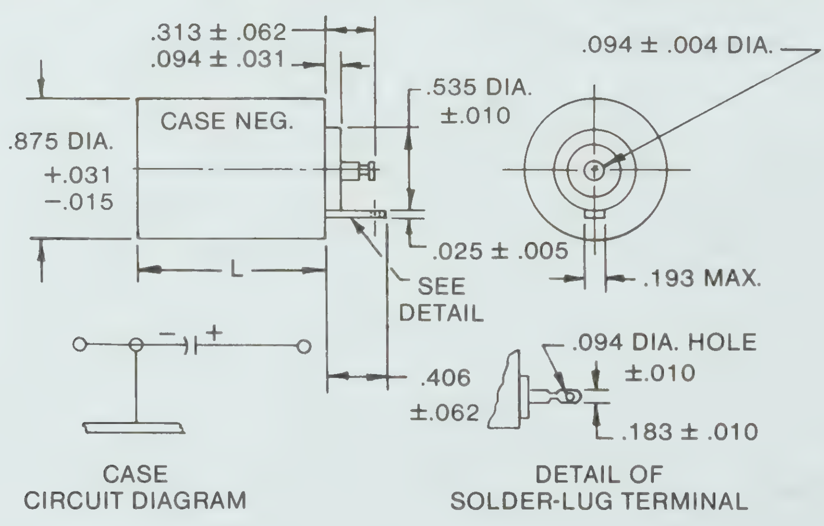
MILITARY CODING SYSTEM

M39006 / 19 - 1000

- 1000 — DASH NUMBER FROM TABLE. For specific value of Capacitance, Capacitance Tolerance, Voltage Fuse Size, and Failure Rate Level the table must be consulted.
- /19 — DETAIL SHEET FOR APPLICABLE STYLE /19 is CLR14.
- M39006 — MIL-C-39006—Generic specification for established reliability non-solid electrolyte tantalum capacitors.

Capacitor characteristics

RATED VOLTAGE (85°C)	CAP.	DC LEAKAGE (Max.) 25°C	DC LEAKAGE (Max.) 85°C	DC LEAKAGE (Max.) 125°C	DISSIPATION FACTOR (max.)	DERATED VOLTAGE (125°C)	SURGE VOLTAGE (85°C)	IMPEDANCE (max.)	DIMENSION L ±.062 (1.57)	PART NO. M39006/19 FAILURE RATE LEVEL (%/1,000 Hr.) L(2.0)	M(1.0)	P(0.1)	R(0.01)	S(0.001)
volts, dc	uF	uA	uA	uA	percent	volts, dc	volts, dc	ohms	inches (mm)					
20	100.0	10	50	80	21.0	18	23	30	0.540 (13.72)	1000	1020	1040	1060	1080
20	200.0	16	80	128	36.0	18	23	20	0.732 (18.59)	1001	1021	1041	1061	1081
30	75.0	11	55	88	15.0	26	34.5	45	0.540 (13.72)	1002	1022	1042	1062	1082
30	150.0	13	90	104	29.0	26	34.5	30	0.732 (18.59)	1003	1023	1043	1063	1083
60	40.0	12	60	96	8.2	52	69	65	0.540 (13.72)	1004	1024	1044	1064	1084
60	80.0	19	95	152	16.0	52	69	35	0.732 (18.59)	1005	1025	1045	1065	1085
90	25.0	11	55	88	5.1	78	103	90	0.540 (13.72)	1006	1026	1046	1066	1086
90	50.0	18	90	144	10.0	78	103	45	0.732 (18.59)	1007	1027	1047	1067	1087
180	12.0	11	55	88	5.1	155	207	180	0.920 (23.37)	1008	1028	1048	1068	1088
180	25.0	18	90	144	10.0	155	207	90	1.300 (33.02)	1009	1029	1049	1069	1089
270	8.0	11	55	88	5.1	235	310	270	1.270 (32.36)	1010	1030	1050	1070	1090
270	16.0	18	90	144	10.0	235	310	135	1.865 (47.37)	1011	1031	1051	1071	1091
360	6.0	11	55	88	5.0	310	414	360	1.635 (41.53)	1012	1032	1052	1072	1092
360	12.0	18	90	144	10.0	310	414	180	2.420 (61.47)	1013	1033	1053	1073	1093
450	5.0	11	55	88	4.9	390	518	450	2.000 (50.80)	1014	1034	1054	1074	1094
450	10.0	18	90	144	9.8	390	518	225	2.980 (75.69)	1015	1035	1055	1075	1095
540	4.0	11	55	88	5.1	470	621	540	2.365 (60.07)	1016	1036	1056	1076	1096
540	8.0	18	90	144	10.0	470	621	270	3.532 (89.71)	1017	1037	1057	1077	1097
630	3.5	11	55	88	5.0	545	724	630	2.720 (69.09)	1018	1038	1058	1078	1098
630	7.0	18	90	144	10.0	545	724	315	4.062(103.17)	1019	1039	1059	1079	1099



CASE CIRCUIT DIAGRAM

DETAIL OF SOLDER-LUG TERMINAL

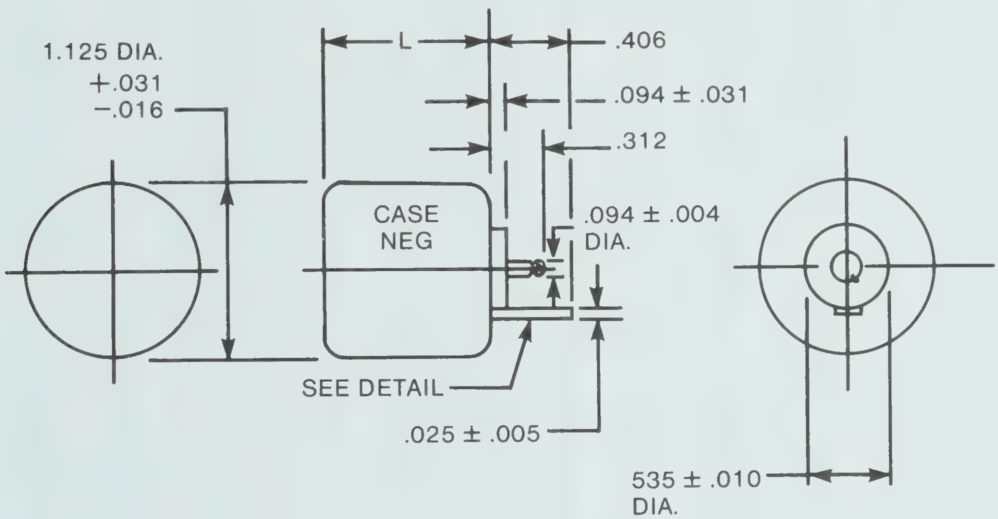
MIL-C-39006/20
STYLE CLR17

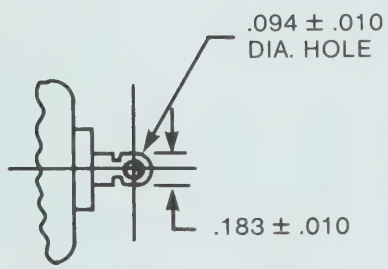
CAPACITORS, FIXED, ELECTROLYTIC (NONSOLID ELECTROLYTE), TANTALUM, (POLARIZED, SINTERED SLUG), 85°C (VOLTAGE DERATED TO 125°C), ESTABLISHED RELIABILITY.

MILITARY CODING SYSTEM

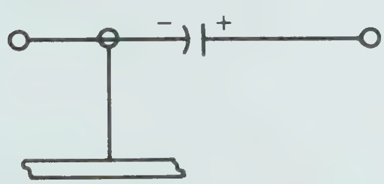
M39006 / 20 - 1000

- 1000 — DASH NUMBER FROM TABLE. For specific value of Capacitance, Capacitance Tolerance, Voltage, Fuse Size, and Failure Rate Level the table must be consulted.
- 20 — DETAIL SHEET FOR APPLICABLE STYLE /20 is CLR17.
- M39006 — MIL-C-39006–Generic specification for established reliability non-solid electrolyte tantalum capacitors.





DETAIL OF
SOLDER-LUG TERMINAL



CIRCUIT DIAGRAM

MIL-C-39006

Military Style Tantalum Capacitors

MIL-C-39006/20
STYLE CLR17

Capacitor characteristics

Rated voltage (+85°C)	Cap.	Cap. toler-ance	DC leakage (max) +25°C	DC leakage (max) +85°C	DC leakage (max) +125°C	Dissi-pation factor (max)	Derated voltage (+125°C)	Surge voltage (+85°C)	Imped-ance (max)	Cap. change (-55°C)	Dimension L ±.062 (1.57)	Part No. M39006/20- (Failure rate level (%/1,000 hr)) L (2.0)	M (1.0)	P (0.1)	R(0.01)	S(0.001)
volts, dc	uF	%	uA	uA	uA	%	volts, dc	volts, dc	ohms	%	inches (mm)					
30	370	±20	18	125	180	39	26	34.5	15	-65	.600 (15.24)	1000	1050	1100	1150	1200
30	370	+50,-15	18	125	180	39	26	34.5	15	-65	.600 (15.24)	1001	1051	1101	1151	1201
30	650	±20	21	145	210	60	26	34.5	15	-85	1.100 (27.94)	1002	1052	1102	1152	1202
30	650	+50,-15	21	145	210	60	26	34.5	15	-85	1.100 (27.94)	1003	1053	1103	1153	1203
30	1300	±20	27	190	270	83	26	34.5	10	-85	1.100 (27.94)	1004	1054	1104	1154	1204
30	1300	+50,-15	27	190	270	83	26	34.5	10	-85	1.100 (27.94)	1005	1055	1105	1155	1205
60	200	±20	19	135	190	22	52	69.0	30	-50	.600 (15.24)	1006	1056	1106	1156	1206
60	200	+50,-15	19	135	190	22	52	69.0	30	-50	.600 (15.24)	1007	1057	1107	1157	1207
60	350	±20	22	155	220	37	52	69.0	25	-70	1.100 (27.94)	1008	1058	1108	1158	1208
60	350	+50,-15	22	155	220	37	52	69.0	25	-70	1.100 (27.94)	1009	1059	1109	1159	1209
60	700	±20	29	200	290	62	52	69.0	15	-70	1.100 (27.94)	1010	1060	1110	1160	1210
60	700	+50,-15	29	200	290	62	52	69.0	15	-70	1.100 (27.94)	1011	1061	1111	1161	1211
90	120	±20	19	135	190	13	78	103.0	40	-40	.600 (15.94)	1012	1062	1112	1162	1212
90	120	+50,-15	19	135	190	13	78	103.0	40	-40	.600 (15.94)	1013	1063	1113	1163	1213
90	220	±20	21	145	210	24	78	103.0	30	-60	1.100 (27.94)	1014	1064	1114	1164	1214
90	220	+50,-15	21	145	210	24	78	103.0	30	-60	1.100 (27.94)	1015	1065	1115	1165	1215
90	450	±20	29	195	290	45	78	103.0	35	-60	1.100 (27.94)	1016	1066	1116	1166	1216
90	450	+50,-15	29	195	290	45	78	103.0	35	-60	1.100 (27.94)	1017	1067	1117	1167	1217
180	42	±20	17	120	170	16	155	207.0	75	-40	.976 (24.79)	1018	1068	1118	1168	1218
180	42	+50,-15	17	120	170	16	155	207.0	75	-40	.976 (24.79)	1019	1069	1119	1169	1219
180	60	±20	19	135	190	13	155	207.0	60	-40	.976 (24.79)	1020	1070	1120	1170	1220
180	60	+50,-15	19	135	190	13	155	207.0	60	-40	.976 (24.79)	1021	1071	1121	1171	1221
180	110	±20	21	145	210	24	155	207.0	60	-60	1.938 (49.23)	1022	1072	1122	1172	1222
180	110	+50, -15	21	145	210	24	155	207.0	60	-60	1.938 (49.23)	1023	1073	1123	1173	1223
180	230	±20	29	200	290	46	155	207.0	50	-60	1.938 (49.23)	1024	1074	1124	1174	1224
180	230	+50,-15	29	200	290	46	155	207.0	50	-60	1.938 (49.23)	1025	1075	1125	1175	1225
270	28	±20	19	120	190	16	235	310.0	80	-40	1.350 (34.29)	1026	1076	1126	1176	1226
270	28	+50,-15	19	120	190	16	235	310.0	80	-40	1.350 (34.29)	1027	1077	1127	1177	1227
270	40	±20	19	135	190	22	235	310.0	100	-40	1.350 (34.29)	1028	1078	1128	1178	1228
270	40	+50,-15	19	135	190	22	235	310.0	100	-40	1.350 (34.29)	1029	1079	1129	1179	1229
270	75	±20	21	145	210	24	235	310.0	90	-60	2.812 (71.42)	1030	1080	1130	1180	1230
270	75	+50,-15	21	145	210	24	235	310.0	90	-60	2.812 (71.42)	1031	1081	1131	1181	1231
270	150	±20	28	195	280	45	235	310.0	75	-60	2.812 (71.42)	1032	1082	1132	1182	1232
270	150	+50,-15	28	195	280	45	235	310.0	75	-60	2.812 (71.42)	1033	1083	1133	1183	1233
360	22	±20	18	125	180	16	310	414.0	100	-40	1.705 (43.31)	1034	1084	1134	1184	1234
360	22	+50,-15	18	125	180	16	310	414.0	100	-40	1.705 (43.31)	1035	1085	1135	1185	1235
360	30	±20	19	135	190	22	310	414.0	120	-40	1.705 (43.31)	1036	1086	1136	1186	1236
360	30	+50,-15	19	135	190	22	310	414.0	120	-40	1.705 (43.31)	1037	1087	1137	1187	1237
450	17	±20	18	125	180	16	390	518.0	130	-40	2.080 (52.83)	1038	1088	1138	1188	1238
450	17	+50,-15	18	125	180	16	390	518.0	130	-40	2.080 (52.83)	1039	1089	1139	1189	1239
450	25	±20	19	135	190	23	390	518.0	150	-40	2.080 (52.83)	1040	1090	1140	1190	1240
450	25	+50,-15	19	135	190	23	390	518.0	150	-40	2.080 (52.83)	1041	1091	1141	1191	1241
540	14	±20	17	120	170	16	470	621.0	160	-40	2.435 (61.85)	1042	1092	1142	1192	1242
540	14	+50,-15	17	120	170	16	470	621.0	160	-40	2.435 (61.85)	1043	1093	1143	1193	1243
540	20	±20	19	135	190	22	470	621.0	170	-40	2.435 (61.85)	1044	1094	1144	1194	1244
540	20	+50,-15	19	135	190	22	470	621.0	170	-40	2.435 (61.85)	1045	1095	1145	1195	1245
630	12	±20	17	120	170	16	545	724.0	180	-40	2.810 (71.37)	1046	1096	1146	1196	1246
630	12	+50,-15	17	120	170	16	545	724.0	180	-40	2.810 (71.37)	1047	1097	1147	1197	1247
630	18	±20	19	135	190	23	545	724.0	200	-40	2.810 (71.37)	1048	1098	1148	1198	1248
630	18	+50,-15	19	135	190	23	545	724.0	200	-40	2.810 (71.37)	1049	1099	1149	1199	1249

MIL-C-39006

Military Style Tantalum Capacitors

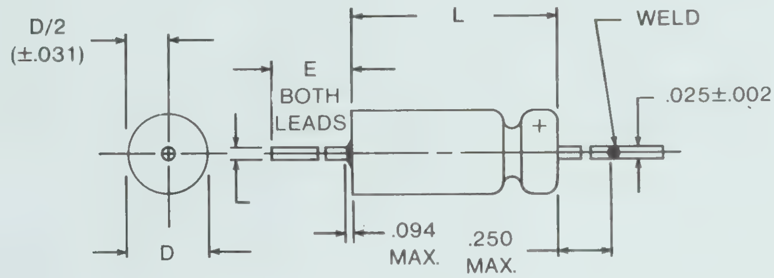
MIL-C-39006/09
STYLE CLR65

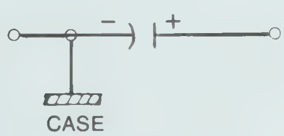
MILITARY CODING SYSTEM

M39006 / 09 - 8000*

- DASH NUMBER FROM TABLE. For specific value of Capacitance, Capacitance Tolerance, Voltage, Fuse Size, and Failure Rate Level the table must be consulted.
- DETAIL SHEET FOR APPLICABLE STYLE - /09 is CLR65.
- MIL-C-39006–Generic specification for established reliability non-solid electrolyte tantalum capacitors.

**Substitution for 2000, 4000 and 6000 Series which cannot carry JAN code.*





CIRCUIT DIAGRAM

© Case size	Dimensions — Inches (mm)			E
	Basic case		Insulated case	
	L 1/ +.031(.79) −.016(.41)	D ±.016(.41)	D max	±.250(6.35)
T1	.453(11.51)	.188(4.78)	.219(5.56)	1.500(38.10)
T2	.641(16.28)	.281(7.14)	.312(7.92)	2.250(57.15)
T3	.766(19.46)	.375(9.53)	.406(10.31)	2.250(57.15)
T4	1.062(26.97)	.375(9.53)	.406(10.31)	2.250(57.15)

1/ Length of basic case; sleeving shall be as specified in MIL-C-39006.

MIL-C-39006

Military Style Tantalum Capacitors

MIL-C-39006/09
STYLE CLR65
TANTALUM-TO-GLASS HERMETIC SEAL

Rated voltage (+85°C)	Cap. 1/	Cap. tolerance	DC leakage (max) +25°C	DC leakage (max) +85°C & +125°C	Dissipation factor (max)	Derated voltage (+125°C)	Surge voltage (+85°C)	Impedance (max)	Capacitance change at -55°C	Capacitance change at +85°C	Capacitance change at +125°C	Case size	Part No. M39006/09- Failure rate level (%/1,000 hr) L (2.0)	M (1.0)	P (0.1)	R (0.01)	S (0.001)
volts, dc	uF	percent	uA	uA	percent	volts, dc	volts, dc	ohms	percent	percent	percent						
6	30	±20	1	2	9.1	4	6.9	100	-40	+10.5	+12	T1	8001	8206	8411	8616	8821
6	30	±10	1	2	9.1	4	6.9	100	-40	+10.5	+12	T1	8002	8207	8412	8617	8822
6	30	± 5	1	2	9.1	4	6.9	100	-40	+10.5	+12	T1	8003	8208	8413	8618	8823
6	*68	±20	1	2	20.4	4	6.9	60	-40	+14	+16	T1	8004	8209	8414	8619	8824
6	*68	±10	1	2	20.4	4	6.9	60	-40	+14	+16	T1	8005	8210	8415	8620	8825
6	*68	± 5	1	2	20.4	4	6.9	60	-40	+14	+16	T1	8006	8211	8416	8621	8826
6	140	±20	1	3	21.3	4	6.9	40	-40	+14	+16	T2	8007	8212	8417	8622	8827
6	140	±10	1	3	21.3	4	6.9	40	-40	+14	+16	T2	8008	8213	8418	8623	8828
6	140	± 5	1	3	21.3	4	6.9	40	-40	+14	+16	T2	8009	8214	8419	8624	8829
6	*270	±20	1	6.5	81.8	4	6.9	25	-44	+17.5	+20	T2	8010	8215	8420	8625	8830
6	*270	±10	1	6.5	81.8	4	6.9	25	-44	+17.5	+20	T2	8011	8216	8421	8626	8831
6	*270	± 5	1	6.5	81.8	4	6.9	25	-44	+17.5	+20	T2	8012	8217	8422	8627	8832
6	330	±20	2	7.9	49.6	4	6.9	20	-44	+14	+16	T3	8013	8218	8423	8628	8833
6	330	±10	2	7.9	49.6	4	6.9	20	-44	+14	+16	T3	8014	8219	8424	8629	8834
6	330	± 5	2	7.9	49.6	4	6.9	20	-44	+14	+16	T3	8015	8220	8425	8630	8835
6	*560	±20	2	13	128.0	4	6.9	25	-64	+17.5	+20	T3	8016	8221	8426	8631	8836
6	*560	±10	2	13	128.0	4	6.9	25	-64	+17.5	+20	T3	8017	8222	8427	8632	8837
6	*560	± 5	2	13	128.0	4	6.9	25	-64	+17.5	+20	T3	8018	8223	8428	8633	8838
6	*1200	±20	3	14	144.4	4	6.9	20	-80	+25	+25	T4	8019	8224	8429	8634	8939
6	*1200	±10	3	14	144.4	4	6.9	20	-80	+25	+25	T4	8020	8225	8430	8635	8840
8	25	±20	1	2	7.6	5	9.2	100	-40	+10.5	+12	T1	8021	8226	8431	8636	8841
8	25	±10	1	2	7.6	5	9.2	100	-40	+10.5	+12	T1	8022	8227	8432	8637	8842
8	25	± 5	1	2	7.6	5	9.2	100	-40	+10.5	+12	T1	8023	8228	8433	8638	8843
8	*56	±20	1	2	17.0	5	9.2	59	-40	+14	+16	T1	8024	8229	8434	8639	8844
8	*56	±10	1	2	17.0	5	9.2	59	-40	+14	+16	T1	8025	8230	8435	8640	8845
8	*56	± 5	1	2	17.0	5	9.2	59	-40	+14	+16	T1	8026	8231	8436	8641	8846
8	*220	±20	1	7	66.4	5	9.2	30	-44	+17.5	+20	T2	8027	8232	8437	8642	8847
8	*220	±10	1	7	66.4	5	9.2	30	-44	+17.5	+20	T2	8028	8233	8438	8643	8848
8	*220	± 5	1	7	66.4	5	9.2	30	-44	+17.5	+20	T2	8029	8234	8439	8644	8849
8	*430	±20	2	14	91.5	5	9.2	25	-64	+17.5	+20	T3	8030	8235	8440	8645	8850
8	*430	±10	2	14	91.5	5	9.2	25	-64	+17.5	+20	T3	8031	8236	8441	8646	8851
8	*430	± 5	2	14	91.5	5	9.2	25	-64	+17.5	+20	T3	8032	8237	8442	8647	8852
8	*850	±20	4	16	65.8	5	9.2	22	-80	+25	+25	T4	8033	8238	8443	8648	8853
8	*850	±10	4	16	65.8	5	9.2	22	-80	+25	+25	T4	8034	8239	8444	8649	8854
10	20	±20	1	2	6.1	7	11.5	175	-32	+10.5	+12	T1	8035	8240	8445	8650	8855
10	20	±10	1	2	6.1	7	11.5	175	-32	+10.5	+12	T1	8036	8241	8446	8651	8856
10	20	± 5	1	2	6.1	7	11.5	175	-32	+10.5	+12	T1	8037	8242	8447	8652	8857
10	*47	±20	1	2	18.1	7	11.5	100	-36	+14	+16	T1	8038	8243	8448	8653	8858
10	*47	±10	1	2	18.1	7	11.5	100	-36	+14	+16	T1	8039	8244	8449	8654	8859
10	*47	± 5	1	2	18.1	7	11.5	100	-36	+14	+16	T1	8040	8245	8450	8655	8860
10	100	±20	1	4	15.2	7	11.5	60	-36	+14	+16	T2	8041	8246	8451	8656	8861
10	100	±10	1	4	15.2	7	11.5	60	-36	+14	+16	T2	8042	8247	8452	8657	8862
10	100	± 5	1	4	15.2	7	11.5	60	-36	+14	+16	T2	8043	8248	8453	8658	8863
10	*180	±20	1	7	54.4	7	11.5	40	-36	+14	+16	T2	8044	8249	8454	8659	8864
10	*180	±10	1	7	54.4	7	11.5	40	-36	+14	+16	T2	8045	8250	8455	8660	8865
10	*180	± 5	1	7	54.4	7	11.5	40	-36	+14	+16	T2	8046	8251	8456	8661	8866
10	250	±20	2	10	37.8	7	11.5	30	-40	+14	+16	T3	8047	8252	8457	8662	8867
10	250	±10	2	10	37.8	7	11.5	30	-40	+14	+16	T3	8048	8253	8458	8663	8868
10	250	± 5	2	10	37.8	7	11.5	30	-40	+14	+16	T3	8049	8254	8459	8664	8869
10	*390	±20	2	16	87.6	7	11.5	25	-64	+17.5	+20	T3	8050	8255	8460	8665	8870
10	*390	±10	2	16	87.6	7	11.5	25	-64	+17.5	+20	T3	8051	8256	8461	8666	8871
10	*390	± 5	2	16	87.6	7	11.5	25	-64	+17.5	+20	T3	8052	8257	8462	8667	8872
10	*750	±20	4	16	56.5	7	11.5	23	-80	+25	+25	T4	8053	8258	8463	8668	8873
10	*750	±10	4	16	56.5	7	11.5	23	-80	+25	+25	T4	8054	8259	8464	8669	8874
15	15	±20	1	2	5.7	10	17.2	155	-24	+10.5	+12	T1	8055	8260	8465	8670	8875
15	15	±10	1	2	5.7	10	17.2	155	-24	+10.5	+12	T1	8056	8261	8466	8671	8876
15	15	± 5	1	2	5.7	10	17.2	155	-24	+10.5	+12	T1	8057	8262	8467	8672	8877
15	*33	±20	1	2	12.5	10	17.2	90	-28	+14	+16	T1	8058	8263	8468	8673	8878
15	*33	±10	1	2	12.5	10	17.2	90	-28	+14	+16	T1	8059	8264	8469	8674	8879
15	*33	± 5	1	2	12.5	10	17.2	90	-28	+14	+16	T1	8060	8265	8470	8675	8880
15	70	±20	1	4	13.1	10	17.2	75	-28	+14	+16	T2	8061	8266	8471	8676	8881
15	70	±10	1	4	13.1	10	17.2	75	-28	+14	+16	T2	8062	8267	8472	8677	8882
15	70	± 5	1	4	13.1	10	17.2	75	-28	+14	+16	T2	8063	8268	8473	8678	8883
15	*120	±20	1	7	36.8	10	17.2	50	-28	+17.5	+20	T2	8064	8269	8474	8679	8884
15	*120	±10	1	7	36.8	10	17.2	50	-28	+17.5	+20	T2	8065	8270	8475	8680	8885
15	*120	± 5	1	7	36.8	10	17.2	50	-28	+17.5	+20	T2	8066	8271	8476	8681	8886
15	170	±20	2	10	25.4	10	17.2	35	-32	+14	+16	T3	8067	8272	8477	8682	8887
15	170	±10	2	10	25.4	10	17.2	35	-32	+14	+16	T3	8068	8273	8478	8683	8888
15	170	± 5	2	10	25.4	10	17.2	35	-32	+14	+16	T3	8069	8274	8479	8684	8889

1/ The asterisk (*) indicates high-capacitance series

MIL-C-39006/09 STYLE CLR65
TANTALUM-TO-GLASS HERMETIC SEAL

Rated voltage (+85°C)	Cap. 1/	Cap. tolerance	DC leakage (max) +25°C	DC leakage (max) +85°C & +125°C	Dissipation factor (max)	Derated voltage (+125°C)	Surge voltage (+85°C)	Impedance (max)	Capacitance change at -55°C	Capacitance change at +85°C	Capacitance change at +125°C	Case size	Part No. M39006/09- Failure rate level (%/1,000 hr) L (2.0)	M (1.0)	P (0.1)	R (0.01)	S (0.001)
volts, dc	uF	percent	uA	uA	percent	volts, dc	volts, dc	ohms	percent	percent	percent						
15	*270	±20	2	16	60.9	10	17.2	30	-56	+17.5	+20	T3	8070	8275	8480	8685	8890
15	*270	±10	2	16	60.9	10	17.2	30	-56	+17.5	+20	T3	8071	8276	8481	8686	8891
15	*270	± 5	2	16	60.9	10	17.2	30	-56	+17.5	+20	T3	8072	8277	8482	8687	8892
15	*540	±20	6	24	49.0	10	17.2	23	-80	+25	+25	T4	8073	8278	8483	8688	8893
15	*540	±10	6	24	49.0	10	17.2	23	-80	+25	+25	T4	8074	8279	8484	8689	8894
25	10	±20	1	2	4.6	15	28.8	220	-16	+ 8	+ 9	T1	8075	8280	8485	8690	8895
25	10	±10	1	2	4.6	15	28.8	220	-16	+ 8	+ 9	T1	8076	8281	8486	8691	8896
25	10	± 5	1	2	4.6	15	28.8	220	-16	+ 8	+ 9	T1	8077	8282	8487	8692	8897
25	*22	±20	1	2	8.3	15	28.8	140	-20	+10.5	+12	T1	8078	8283	8488	8693	8898
25	*22	±10	1	2	8.3	15	28.8	140	-20	+10.5	+12	T1	8079	8284	8489	8694	8899
25	*22	± 5	1	2	8.3	15	28.8	140	-20	+10.5	+12	T1	8080	8285	8490	8695	8900
25	*100	±20	1	10	31.4	15	28.8	50	-28	+13	+15	T2	8081	8286	8491	8696	8901
25	*100	±10	1	10	31.4	15	28.8	50	-28	+13	+15	T2	8082	8287	8492	8697	8902
25	*100	± 5	1	10	31.4	15	28.8	50	-28	+13	+15	T2	8083	8288	8493	8698	8903
25	*180	±20	2	18	54.3	15	28.8	32	-48	+13	+15	T3	8084	8289	8494	8699	8904
25	*180	±10	2	18	54.3	15	28.8	32	-48	+13	+15	T3	8085	8290	8495	8700	8905
25	*180	± 5	2	18	54.3	15	28.8	32	-48	+13	+15	T3	8086	8291	8496	8701	8906
25	*350	±20	7	28	35.0	15	28.8	24	-70	+25	+25	T4	8087	8292	8497	8702	8907
25	*350	±10	7	28	35.0	15	28.8	24	-70	+25	+25	T4	8088	8293	8498	8703	8908
30	8	±20	1	2	4.5	20	34.5	275	-16	+ 8	+12	T1	8089	8294	8499	8704	8909
30	8	±10	1	2	4.5	20	34.5	275	-16	+ 8	+12	T1	8090	8295	8500	8705	8910
30	8	± 5	1	2	4.5	20	34.5	275	-16	+ 8	+12	T1	8091	8296	8501	8706	8911
30	*15	±20	1	2	9.1	20	34.5	175	-20	+10.5	+12	T1	8092	8297	8502	8707	8912
30	*15	±10	1	2	9.1	20	34.5	175	-20	+10.5	+12	T1	8093	8298	8503	8708	8913
30	*15	± 5	1	2	9.1	20	34.5	175	-20	+10.5	+12	T1	8094	8299	8504	8709	8914
30	40	±20	1	5	12.2	20	34.5	65	-24	+10.5	+12	T2	8095	8300	8505	8710	8915
30	40	±10	1	5	12.2	20	34.5	65	-24	+10.5	+12	T2	8096	8301	8506	8711	8916
30	40	± 5	1	5	12.2	20	34.5	65	-24	+10.5	+12	T2	8097	8302	8507	8712	8917
30	*68	±20	1	8	31.0	20	34.5	60	-24	+13	+15	T2	8098	8303	8508	8713	8918
30	*68	±10	1	8	31.0	20	34.5	60	-24	+13	+15	T2	8099	8304	8509	8714	8919
30	*68	± 5	1	8	31.0	20	34.5	60	-24	+13	+15	T2	8100	8305	8510	8715	8920
30	100	±20	2	12	19.0	20	34.5	40	-28	+10.5	+12	T3	8101	8306	8511	8716	8921
30	100	±10	2	12	19.0	20	34.5	40	-28	+10.5	+12	T3	8102	8307	8512	8717	8922
30	100	± 5	2	12	19.0	20	34.5	40	-28	+10.5	+12	T3	8103	8308	8513	8718	8923
30	*150	±20	2	18	46.0	20	34.5	35	-48	+13	+15	T3	8104	8309	8514	8719	8924
30	*150	±10	2	18	46.0	20	34.5	35	-48	+13	+15	T3	8105	8310	8515	8720	8925
30	*150	± 5	2	18	46.0	20	34.5	35	-48	+13	+15	T3	8106	8311	8516	8721	8926
30	*300	±20	8	32	35.0	20	34.5	25	-60	+25	+25	T4	8107	8312	8517	8722	8927
30	*300	±10	8	32	35.0	20	34.5	25	-60	+25	+25	T4	8108	8313	8518	8723	8928
50	5	±20	1	2	3.4	30	57.5	400	-16	+ 5	+ 6	T1	8109	8314	8519	8724	8929
50	5	±10	1	2	3.4	30	57.5	400	-16	+ 5	+ 6	T1	8110	8315	8520	8725	8930
50	5	± 5	1	2	3.4	30	57.5	400	-16	+ 5	+ 6	T1	8111	8316	8521	8726	8931
50	*10	±20	1	2	6.0	30	57.5	250	-24	+ 8	+ 9	T1	8112	8317	8522	8727	8932
50	*10	±10	1	2	6.0	30	57.5	250	-24	+ 8	+ 9	T1	8113	8318	8523	8728	8933
50	*10	± 5	1	2	6.0	30	57.5	250	-24	+ 8	+ 9	T1	8114	8319	8524	8729	8934
50	25	±20	1	5	11.2	30	57.5	95	-20	+10.5	+12	T2	8115	8320	8525	8730	8935
50	25	±10	1	5	11.2	30	57.5	95	-20	+10.5	+12	T2	8116	8321	8526	8731	8936
50	25	± 5	1	5	11.2	30	57.5	95	-20	+10.5	+12	T2	8117	8322	8527	8732	8937
50	*47	±20	1	9	21.4	30	57.5	70	-28	+13	+15	T2	8118	8323	8528	8733	8938
50	*47	±10	1	9	21.4	30	57.5	70	-28	+13	+15	T2	8119	8324	8529	8734	8939
50	*47	± 5	1	9	21.4	30	57.5	70	-28	+13	+15	T2	8120	8325	8530	8735	8940
50	60	±20	2	12	13.6	30	57.5	45	-16	+10.5	+12	T3	8121	8326	8531	8736	8941
50	60	±10	2	12	13.6	30	57.5	45	-16	+10.5	+12	T3	8122	8327	8532	8737	8942
50	60	± 5	2	12	13.6	30	57.5	45	-16	+10.5	+12	T3	8123	8328	8533	8738	8943
50	*82	±20	2	16	24.9	30	57.5	45	-32	+13	+15	T3	8124	8329	8534	8739	8944
50	*82	±10	2	16	24.9	30	57.5	45	-32	+13	+15	T3	8125	8330	8535	8740	8945
50	*82	± 5	2	16	24.9	30	57.5	45	-32	+13	+15	T3	8126	8331	8536	8741	8946
50	*160	±20	8	32	25.7	30	57.5	27	-50	+25	+25	T4	8127	8332	8537	8742	8947
50	*160	±10	8	32	25.7	30	57.5	27	-50	+25	+25	T4	8128	8333	8538	8743	8948
60	4	±20	1	2	3.0	40	69.0	550	-16	+ 5	+ 6	T1	8129	8334	8539	8744	8949
60	4	±10	1	2	3.0	40	69.0	550	-16	+ 5	+ 6	T1	8130	8335	8540	8745	8950
60	4	± 5	1	2	3.0	40	69.0	550	-16	+ 5	+ 6	T1	8131	8336	8541	8746	8951
60	*8.2	±20	1	2	5.0	40	69.0	275	-24	+ 8	+ 9	T1	8132	8337	8542	8747	8952
60	*8.2	±10	1	2	5.0	40	69.0	275	-24	+ 8	+ 9	T1	8133	8338	8543	8748	8953
60	*8.2	± 5	1	2	5.0	40	69.0	275	-24	+ 8	+ 9	T1	8134	8339	8544	8749	8954
60	20	±20	1	5	7.6	40	69.0	105	-16	+10.5	+12	T2	8135	8340	8545	8750	8955
60	20	±10	1	5	7.6	40	69.0	105	-16	+10.5	+12	T2	8136	8341	8546	8751	8956
60	20	± 5	1	5	7.6	40	69.0	105	-16	+10.5	+12	T2	8137	8342	8547	8752	8957
60	*39	±20	1	9	20.7	40	69.0	90	-28	+10.5	+12	T2	8138	8343	8548	8753	8958
60	*39	±10	1	9	20.7	40	69.0	90	-28	+10.5	+12	T2	8139	8344	8549	8754	8959
60	*39	± 5	1	9	20.7	40	69.0	90	-28	+10.5	+12	T2	8140	8345	8550	8755	8960

1/ The asterisk (*) indicates high-capacitance series.

MIL-C-39006
Military Style Tantalum Capacitors

MIL-C-39006/09
STYLE CLR65
TANTALUM-TO-GLASS HERMETIC SEAL

Rated voltage (+85°C)	Cap. 1/	Cap. toler-ance	DC leakage (max)		Dissi-pation factor (max)	Derated voltage (+125 C)	Surge voltage (+85°C)	Imped-ance (max)	Capacitance change at			Case size	Part No. M39006/09- Failure rate level (%/1,000 hr)				
			+25 C	+85°C & +125°C					-55°C	+85°C	+125°C		L (2.0)	M (1.0)	P (0.1)	R (0.01)	S (0.001)
volts, dc	uF	percent	uA	uA	percent	volts, dc	volts, dc	ohms	percent	percent	percent						
60	50	±20	2	12	15.3	40	69.0	50	-16	+10.5	+12	T3	8141	8346	8551	8756	8961
60	50	±10	2	12	15.3	40	69.0	50	-16	+10.5	+12	T3	8142	8347	8552	8757	8962
60	50	± 5	2	12	15.3	40	69.0	50	-16	+10.5	+12	T3	8143	8348	8553	8758	8963
60	*68	±20	2	16	20.7	40	69.0	50	-32	+10.5	+12	T3	8144	8349	8554	8759	8964
60	*68	±10	2	16	20.7	40	69.0	50	-32	+10.5	+12	T3	8145	8350	8555	8760	8965
60	*68	± 5	2	16	20.7	40	69.0	50	-32	+10.5	+12	T3	8146	8351	8556	8761	8966
60	*140	±20	8	32	25.7	40	69.0	28	-40	+20	+20	T4	8147	8352	8557	8762	8967
60	*140	±10	8	32	25.7	40	69.0	28	-40	+20	+20	T4	8148	8353	8558	8763	8968
75	3 5	±20	1	2	2.5	50	86.2	650	-16	+ 5	+ 6	T1	8149	8354	8559	8764	8969
75	3.5	±10	1	2	2.5	50	86.2	650	-16	+ 5	+ 6	T1	8150	8355	8560	8765	8970
75	3.5	± 5	1	2	2.5	50	86.2	650	-16	+ 5	+ 6	T1	8151	8356	8561	8766	8971
75	*6.8	±20	1	2	4.1	50	86.2	300	-20	+ 8	+ 9	T1	8152	8357	8562	8767	8972
75	*6.8	±10	1	2	4.1	50	86.2	300	-20	+ 8	+ 9	T1	8153	8358	8563	8768	8973
75	*6.8	± 5	1	2	4.1	50	86.2	300	-20	+ 8	+ 9	T1	8154	8359	8564	8769	8974
75	15	±20	1	5	7.5	50	86.2	150	-16	+ 8	+ 9	T2	8155	8360	8565	8770	8975
75	15	±10	1	5	7.5	50	86.2	150	-16	+ 8	+ 9	T2	8156	8361	8566	8771	8976
75	15	± 5	1	5	7.5	50	86.2	150	-16	+ 8	+ 9	T2	8157	8362	8567	8772	8977
75	*33	±20	1	10	17.5	50	86.2	90	-24	+10.5	+15	T2	8158	8363	8568	8773	8978
75	*33	±10	1	10	17.5	50	86.2	90	-24	+10.5	+15	T2	8159	8364	8569	8774	8979
75	*33	± 5	1	10	17.5	50	86.2	90	-24	+10.5	+15	T2	8160	8365	8570	8775	8980
75	40	±20	2	12	15.2	50	86.2	60	-16	+10.5	+12	T3	8161	8366	8571	8776	8981
75	40	±10	2	12	15.2	50	86.2	60	-16	+10.5	+12	T3	8162	8367	8572	8777	8982
75	40	± 5	2	12	15.2	50	86.2	60	-16	+10.5	+12	T3	8163	8368	8573	8778	8983
75	*56	±20	2	17	26.0	50	86.2	60	-28	+10.5	+15	T3	8164	8369	8574	8779	8984
75	*56	±10	2	17	26.0	50	86.2	60	-28	+10.5	+15	T3	8165	8370	8575	8780	8985
75	*56	± 5	2	17	26.0	50	86.2	60	-28	+10.5	+15	T3	8166	8371	8576	8781	8986
75	*110	±20	9	36	25.7	50	86.2	29	-35	+20	+20	T4	8167	8372	8577	8782	8987
75	*110	±10	9	36	25.7	50	86.2	29	-35	+20	+20	T4	8168	8373	8578	8783	8988
100	2.5	±20	1	2	5.0	65	115	950	-16	+ 7	+ 8	T1	8169	8374	8579	8784	8989
100	2.5	±10	1	2	5.0	65	115	950	-16	+ 7	+ 8	T1	8170	8375	8580	8785	8990
100	2.5	± 5	1	2	5.0	65	115	950	-16	+ 7	+ 8	T1	8171	8376	8581	8786	8991
100	*4.7	±20	1	2	3.6	65	115	500	-16	+ 7	+ 8	T1	8172	8377	8582	8787	8992
100	*4.7	±10	1	2	3.6	65	115	500	-16	+ 7	+ 8	T1	8173	8378	8583	8788	8993
100	*4.7	± 5	1	2	3.6	65	115	500	-16	+ 7	+ 8	T1	8174	8379	8584	8789	8994
100	11	±20	1	4	5.0	65	115	200	-16	+ 7	+ 8	T2	8175	8380	8585	8790	8995
100	11	±10	1	4	5.0	65	115	200	-16	+ 7	+ 8	T2	8176	8381	8586	8791	8996
100	11	± 5	1	4	5.0	65	115	200	-16	+ 7	+ 8	T2	8177	8382	8587	8792	8997
100	*22	±20	1	9	11.8	65	115	100	-16	+ 7	+ 8	T2	8178	8383	8588	8793	8998
100	*22	±10	1	9	11.8	65	115	100	-16	+ 7	+ 8	T2	8179	8384	8589	8794	8999
100	*22	± 5	1	9	11.8	65	115	100	-16	+ 7	+ 8	T2	8180	8385	8590	8795	9000
100	30	±20	2	12	9.1	65	115	80	-16	+ 7	+ 8	T3	8181	8386	8591	8796	9001
100	30	±10	2	12	9.1	65	115	80	-16	+ 7	+ 8	T3	8182	8387	8592	8797	9002
100	30	± 5	2	12	9.1	65	115	80	-16	+ 7	+ 8	T3	8183	8388	8593	8798	9003
100	*43	±20	2	17	19.7	65	115	70	-20	+ 7	+ 8	T3	8184	8389	8594	8799	9004
100	*43	±10	2	17	19.7	65	115	70	-20	+ 7	+ 8	T3	8185	8390	8595	8800	9005
100	*43	± 5	2	17	19.7	65	115	70	-20	+ 7	+ 8	T3	8186	8391	8596	8801	9006
100	*86	±20	9	36	20.7	65	115	30	-25	+15	+15	T4	8187	8392	8597	8802	9007
100	*86	±10	9	36	20.7	65	115	30	-25	+15	+15	T4	8188	8393	8598	8803	9008
125	1.7	±20	1	2	7.0	85	144	1250	-16	+ 7	+ 8	T1	8189	8394	8599	8804	9009
125	1.7	±10	1	2	7.0	85	144	1250	-16	+ 7	+ 8	T1	8190	8395	8600	8805	9010
125	1.7	± 5	1	2	7.0	85	144	1250	-16	+ 7	+ 8	T1	8191	8396	8601	8806	9011
125	*3.6	±20	1	2	4.1	85	144	600	-16	+ 7	+ 8	T1	8192	8397	8602	8807	9012
125	*3.6	±10	1	2	4.1	85	144	600	-16	+ 7	+ 8	T1	8193	8398	8603	8808	9013
125	*3.6	± 5	1	2	4.1	85	144	600	-16	+ 7	+ 8	T1	8194	8399	8604	8809	9014
125	9	±20	1	5	10.2	85	144	240	-16	+ 7	+ 8	T2	8195	8400	8605	8810	9015
125	9	±10	1	5	10.2	85	144	240	-16	+ 7	+ 8	T2	8196	8401	8606	8811	9016
125	9	± 5	1	5	10.2	85	144	240	-16	+ 7	+ 8	T2	8197	8402	8607	8812	9017
125	*14	±20	1	7	12.7	85	144	167	-16	+ 7	+ 8	T2	8198	8403	8608	8813	9018
125	*14	±10	1	7	12.7	85	144	167	-16	+ 7	+ 8	T2	8199	8404	8609	8814	9019
125	*14	± 5	1	7	12.7	85	144	167	-16	+ 7	+ 8	T2	8200	8405	8610	8815	9020
125	18	±20	2	9	15.0	85	144	129	-16	+ 7	+ 8	T3	8201	8406	8611	8816	9021
125	18	±10	2	9	15.0	85	144	129	-16	+ 7	+ 8	T3	8202	8407	8612	8817	9022
125	18	± 5	2	9	15.0	85	144	129	-16	+ 7	+ 8	T3	8203	8408	8613	8818	9023
125	*25	±20	2	13	19.0	85	144	93	-16	+ 7	+ 8	T3	8204	8409	8614	8819	9024
125	*25	±10	2	13	19.0	85	144	93	-16	+ 7	+ 8	T3	8205	8410	8615	8820	9025
125	*25	± 5	2	13	19.0	85	144	93	-16	+ 7	+ 8	T3	9026	9029	9032	9035	9038
125	*56	±20	10	40	17.5	85	144	32	-25	+15	+15	T4	9027	9030	9033	9036	9039
125	*56	±10	10	40	17.5	85	144	32	-25	+15	+15	T4	9028	9031	9034	9037	9040

1/ The asterisk (*) indicates high-capacitance series. NOTE: "L" Level Inactive for New Design.

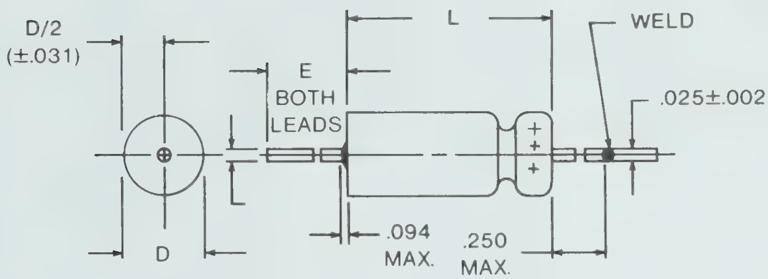
3 *Tantalum Capacitors*

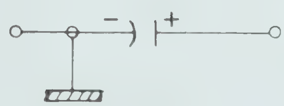
MIL-C-39006/22
STYLE CLR79
APPROVED BY DESC TO THE
"H" CHARACTERISTIC

MILITARY CODING SYSTEM

M39006/22-0437

- DASH NUMBER FROM TABLE. For specific value of Capacitance, Capacitance Tolerance, Voltage, Case Size, and Failure Rate Level the table must be consulted
- DETAIL SHEET FOR APPLICABLE STYLE — /22 is CLR 79.
- MIL-C-39006–Generic specification for established reliability non-solid electrolyte tantalum capacitors.





CIRCUIT DIAGRAM

Case size	Dimensions — Inches (mm)			
	Basic case		Insulated case	
	L* +.031 (.79) −.016 (.41)	D ±.016 (.41)	D max	E ±.250 (6.35)
T1	.453 (11.51)	.188 (4.78)	.219 (5.56)	1.500 (38.10)
T2	.641 (16.28)	.281 (7.14)	.312 (7.92)	2.250 (57.15)
T3	.766 (19.46)	.375 (9.53)	.406 (10.31)	2.250 (57.15)
T4	1.062 (26.97)	.375 (9.53)	.406 (10.31)	2.250 (57.15)

**Length of basic case; sleeving shall be as specified in MIL-C-39006.*
Failure rate level "L" inactive for new design after May 22, 1976.

MIL-C-39006

Military Style Tantalum Capacitors

MIL-C-39006/22
STYLE CLR79

1/ Rated voltage (+85°C)	Cap.	Cap. tolerance	DC leakage (max) +25°C	DC leakage (max) +85°C & +125°C	Dissipation factor (max)	Derated voltage (+125°C)	Surge voltage (+85°C)	Impedance (max)	Capacitance change at -55°C	Capacitance change at +85°C	Capacitance change at +125°C	2/Max. 85°C 40 kHz ripple current	Case size	Part No. M39006/22-* Failure rate level (%/1,000 hr) M(1.0)	P(0.1)	R(0.01)	S(0.001)
Vdc	uF	%	uA	uA	%	Vdc	Vdc	Ohms	%	%	%	mA rms					
6	30	±20	1	2	9	4	6.9	100	-40	+10.5	+12	820	T1	0001	0221	0441	0661
6	30	±10	1	2	9	4	6.9	100	-40	+10.5	+12	820	T1	0002	0222	0442	0662
6	30	± 5	1	2	9	4	6.9	100	-40	+10.5	+12	820	T1	0003	0223	0443	0663
6	68	±20	1	2	15	4	6.9	60	-40	+14	+16	960	T1	0004	0224	0444	0664
6	68	±10	1	2	15	4	6.9	60	-40	+14	+16	960	T1	0005	0225	0445	0665
6	68	± 5	1	2	15	4	6.9	60	-40	+14	+16	960	T1	0006	0226	0446	0666
6	140	±20	1	3	21	4	6.9	40	-40	+14	+16	1200	T2	0007	0227	0447	0667
6	140	±10	1	3	21	4	6.9	40	-40	+14	+16	1200	T2	0008	0228	0448	0668
6	140	± 5	1	3	21	4	6.9	40	-40	+14	+16	1200	T2	0009	0229	0449	0669
6	270	±20	1	6.5	45	4	6.9	25	-44	+17.5	+20	1375	T2	0010	0230	0450	0670
6	270	±10	1	6.5	45	4	6.9	25	-44	+17.5	+20	1375	T2	0011	0231	0451	0671
6	270	± 5	1	6.5	45	4	6.9	25	-44	+17.5	+20	1375	T2	0012	0232	0452	0672
6	330	±20	2	7.9	36	4	6.9	20	-44	+14	+16	1800	T3	0013	0233	0453	0673
6	330	±10	2	7.9	36	4	6.9	20	-44	+14	+16	1800	T3	0014	0234	0454	0674
6	330	± 5	2	7.9	36	4	6.9	20	-44	+14	+16	1800	T3	0015	0235	0455	0675
6	560	+20	2	13	55	4	6.9	25	-64	+17.5	+20	1900	T3	0016	0236	0456	0676
6	560	±10	2	13	55	4	6.9	25	-64	+17.5	+20	1900	T3	0017	0237	0457	0677
6	560	± 5	2	13	55	4	6.9	25	-64	+17.5	+20	1900	T3	0018	0238	0458	0678
6	1200	±20	3	14	90	4	6.9	20	-80	+25	+25	2265	T4	0019	0239	0459	0679
6	1200	±10	3	14	90	4	6.9	20	-80	+25	+25	2265	T4	0020	0240	0460	0680
8	25	±20	1	2	7.5	5	9.2	100	-40	+10.5	+12	820	T1	0021	0241	0461	0681
8	25	±10	1	2	7.5	5	9.2	100	-40	+10.5	+12	820	T1	0022	0242	0462	0682
8	25	± 5	1	2	7.5	5	9.2	100	-40	+10.5	+12	820	T1	0023	0243	0463	0683
8	56	±20	1	2	14	5	9.2	59	-40	+14	+16	900	T1	0024	0244	0464	0684
8	56	±10	1	2	14	5	9.2	59	-40	+14	+16	900	T1	0025	0245	0465	0685
8	56	± 5	1	2	14	5	9.2	59	-40	+14	+16	900	T1	0026	0246	0466	0686
8	120	±20	1	2	20	5	9.2	50	-44	+17.5	+20	1220	T2	0027	0247	0467	0687
8	120	±10	1	2	20	5	9.2	50	-44	+17.5	+20	1220	T2	0028	0248	0468	0688
8	120	± 5	1	2	20	5	9.2	50	-44	+17.5	+20	1220	T2	0029	0249	0469	0689
8	220	±20	1	7	37	5	9.2	30	-44	+17.5	+20	1370	T2	0030	0250	0470	0690
8	220	±10	1	7	37	5	9.2	30	-44	+17.5	+20	1370	T2	0031	0251	0471	0691
8	220	± 5	1	7	37	5	9.2	30	-44	+17.5	+20	1370	T2	0032	0252	0472	0692
8	290	±20	2	6	34	5	9.2	25	-64	+17.5	+20	1770	T3	0033	0253	0473	0693
8	290	±10	2	6	34	5	9.2	25	-64	+17.5	+20	1770	T3	0034	0254	0474	0694
8	290	± 5	2	6	34	5	9.2	25	-64	+17.5	+20	1770	T3	0035	0255	0475	0695
8	430	±20	2	14	46	5	9.2	25	-64	+17.5	+20	1825	T3	0036	0256	0476	0696
8	430	±10	2	14	46	5	9.2	25	-64	+17.5	+20	1825	T3	0037	0257	0477	0697
8	430	± 5	2	14	46	5	9.2	25	-64	+17.5	+20	1825	T3	0038	0258	0478	0698
8	850	±20	4	16	60	5	9.2	22	-80	+25	+25	2330	T4	0039	0259	0479	0699
8	850	±10	4	16	60	5	9.2	22	-80	+25	+25	2330	T4	0040	0260	0480	0700
10	20	±20	1	2	6	7	11.5	175	-32	+10.5	+12	820	T1	0041	0261	0481	0701
10	20	±10	1	2	6	7	11.5	175	-32	+10.5	+12	820	T1	0042	0262	0482	0702
10	20	± 5	1	2	6	7	11.5	175	-32	+10.5	+12	820	T1	0043	0263	0483	0703
10	47	±20	1	2	13	7	11.5	100	-36	+14	+16	855	T1	0044	0264	0484	0704
10	47	±10	1	2	13	7	11.5	100	-36	+14	+16	855	T1	0045	0265	0485	0705
10	47	± 5	1	2	13	7	11.5	100	-36	+14	+16	855	T1	0046	0266	0486	0706
10	100	±20	1	4	15	7	11.5	60	-36	+14	+16	1200	T2	0047	0267	0487	0707
10	100	±10	1	4	15	7	11.5	60	-36	+14	+16	1200	T2	0048	0268	0488	0708
10	100	± 5	1	4	15	7	11.5	60	-36	+14	+16	1200	T2	0049	0269	0489	0709
10	180	±20	1	7	30	7	11.5	40	-36	+14	+16	1365	T2	0050	0270	0490	0710
10	180	±10	1	7	30	7	11.5	40	-36	+14	+16	1365	T2	0051	0271	0491	0711
10	180	± 5	1	7	30	7	11.5	40	-36	+14	+16	1365	T2	0052	0272	0492	0712
10	250	±20	2	10	30	7	11.5	30	-40	+14	+16	1720	T3	0053	0273	0493	0713
10	250	±10	2	10	30	7	11.5	30	-40	+14	+16	1720	T3	0054	0274	0494	0714
10	250	± 5	2	10	30	7	11.5	30	-40	+14	+16	1720	T3	0055	0275	0495	0715
10	390	±20	2	16	44	7	11.5	25	-64	+17.5	+20	1800	T3	0056	0276	0496	0716
10	390	±10	2	16	44	7	11.5	25	-64	+17.5	+20	1800	T3	0057	0277	0497	0717
10	390	± 5	2	16	44	7	11.5	25	-64	+17.5	+20	1800	T3	0058	0278	0498	0718
10	750	±20	4	16	50	7	11.5	23	-80	+25	+25	2360	T4	0059	0279	0499	0719
10	750	±10	4	16	50	7	11.5	23	-80	+25	+25	2360	T4	0060	0280	0500	0720

See footnotes at end of table.

MIL-C-39006/22
STYLE CLR79

1/ Rated voltage (+85°C)	Cap.	Cap. toler-ance	DC leakage (max) +25°C	DC leakage (max) +85°C & +125°C	Dissi-pation factor (max)	Derated voltage (+125°C)	Surge voltage (+85°C)	Imped-ance (max)	Capacitance change at -55°C	Capacitance change at +85°C	Capacitance change at +125°C	2/Max. 85°C 40 kHz ripple current	Case size	Part No. M39006/22-* Failure rate level (%/1,000 hr) M(1.0)	P(0.1)	R(0.01)	S(0.001)
Vdc	uF	%	uA	uA	%	Vdc	Vdc	Ohms	%	%	%	mA rms					
15	15	±20	1	2	5	10	17.2	155	-24	+10.5	+12	780	T1	0061	0281	0501	0721
15	15	±10	1	2	5	10	17.2	155	-24	+10.5	+12	780	T1	0062	0282	0502	0722
15	15	± 5	1	2	5	10	17.2	155	-24	+10.5	+12	780	T1	0063	0283	0503	0723
15	33	±20	1	2	10	10	17.2	90	-28	+14	+16	820	T1	0064	0284	0504	0724
15	33	±10	1	2	10	10	17.2	90	-28	+14	+16	820	T1	0065	0285	0505	0725
15	33	± 5	1	2	10	10	17.2	90	-28	+14	+16	820	T1	0066	0286	0506	0726
15	70	±20	1	4	13	10	17.2	75	-28	+14	+16	1150	T2	0067	0287	0507	0727
15	70	±10	1	4	13	10	17.2	75	-28	+14	+16	1150	T2	0068	0288	0508	0728
15	70	± 5	1	4	13	10	17.2	75	-28	+14	+16	1150	T2	0069	0289	0509	0729
15	120	±20	1	7	18	10	17.2	50	-28	+17.5	+20	1450	T2	0070	0290	0510	0730
15	120	±10	1	7	18	10	17.2	50	-28	+17.5	+20	1450	T2	0071	0291	0511	0731
15	120	± 5	1	7	18	10	17.2	50	-28	+17.5	+20	1450	T2	0072	0292	0512	0732
15	170	±20	2	10	25	10	17.2	35	-32	+14	+16	1480	T3	0073	0293	0513	0733
15	170	±10	2	10	25	10	17.2	35	-32	+14	+16	1480	T3	0074	0294	0514	0734
15	170	± 5	2	10	25	10	17.2	35	-32	+14	+16	1480	T3	0075	0295	0515	0735
15	270	±20	2	16	32	10	17.2	30	-56	+17.5	+20	1740	T3	0076	0296	0516	0736
15	270	±10	2	16	32	10	17.2	30	-56	+17.5	+20	1740	T3	0077	0297	0517	0737
15	270	± 5	2	16	32	10	17.2	30	-56	+17.5	+20	1740	T3	0078	0298	0518	0738
15	540	±20	6	24	40	10	17.2	23	-80	+25	+25	2300	T4	0079	0299	0519	0739
15	540	±10	6	24	40	10	17.2	23	-80	+25	+25	2300	T4	0080	0300	0520	0740
25	10	±20	1	2	4	15	28.8	220	-16	+ 8	+ 9	715	T1	0081	0301	0521	0741
25	10	±10	1	2	4	15	28.8	220	-16	+ 8	+ 9	715	T1	0082	0302	0522	0742
25	10	± 5	1	2	4	15	28.8	220	-16	+ 8	+ 9	715	T1	0083	0303	0523	0743
25	22	±20	1	2	6.6	15	28.8	140	-20	+10.5	+12	825	T1	0084	0304	0524	0744
25	22	±10	1	2	6.6	15	28.8	140	-20	+10.5	+12	825	T1	0085	0305	0525	0745
25	22	± 5	1	2	6.6	15	28.8	140	-20	+10.5	+12	825	T1	0086	0306	0526	0746
25	50	±20	1	2	11	15	28.8	70	-28	+13	+15	1130	T2	0087	0307	0527	0747
25	50	±10	1	2	11	15	28.8	70	-28	+13	+15	1130	T2	0088	0308	0528	0748
25	50	± 5	1	2	11	15	28.8	70	-28	+13	+15	1130	T2	0089	0309	0529	0749
25	100	±20	1	10	15	15	28.8	50	-28	+13	+15	1435	T2	0090	0310	0530	0750
25	100	±10	1	10	15	15	28.8	50	-28	+13	+15	1435	T2	0091	0311	0531	0751
25	100	± 5	1	10	15	15	28.8	50	-28	+13	+15	1435	T2	0092	0312	0532	0752
25	120	±20	2	6	21	15	28.8	38	-32	+13	+15	1450	T3	0093	0313	0533	0753
25	120	±10	2	6	21	15	28.8	38	-32	+13	+15	1450	T3	0094	0314	0534	0754
25	120	± 5	2	6	21	15	28.8	38	-32	+13	+15	1450	T3	0095	0315	0535	0755
25	180	±20	2	18	26	15	28.8	32	-48	+13	+15	1525	T3	0096	0316	0536	0756
25	180	±10	2	18	26	15	28.8	32	-48	+13	+15	1525	T3	0097	0317	0537	0757
25	180	± 5	2	18	26	15	28.8	32	-48	+13	+15	1525	T3	0098	0318	0538	0758
25	350	±20	7	28	35	15	28.8	24	-70	+25	+25	1970	T4	0099	0319	0539	0759
25	350	±10	7	28	35	15	28.8	24	-70	+25	+25	1970	T4	0100	0320	0540	0760
30	8	±20	1	2	4	20	34.5	275	-16	+ 8	+12	640	T1	0101	0321	0541	0761
30	8	±10	1	2	4	20	34.5	275	-16	+ 8	+12	640	T1	0102	0322	0542	0762
30	8	± 5	1	2	4	20	34.5	275	-16	+ 8	+12	640	T1	0103	0323	0543	0763
30	15	±20	1	2	5	20	34.5	175	-20	+10.5	+12	780	T1	0104	0324	0544	0764
30	15	±10	1	2	5	20	34.5	175	-20	+10.5	+12	780	T1	0105	0325	0545	0765
30	15	± 5	1	2	5	20	34.5	175	-20	+10.5	+12	780	T1	0106	0326	0546	0766
30	40	±20	1	5	10	20	34.5	65	-24	+10.5	+12	1120	T2	0107	0327	0547	0767
30	40	±10	1	5	10	20	34.5	65	-24	+10.5	+12	1120	T2	0108	0328	0548	0768
30	40	± 5	1	5	10	20	34.5	65	-24	+10 5	+12	1120	T2	0109	0329	0549	0769
30	68	±20	1	8	13	20	34.5	60	-24	+13	+15	1285	T2	0110	0330	0550	0770
30	68	±10	1	8	13	20	34.5	60	-24	+13	+15	1285	T2	0111	0331	0551	0771
30	68	± 5	1	8	13	20	34.5	60	-24	+13	+15	1285	T2	0112	0332	0552	0772
30	100	±20	2	12	17	20	34.5	40	-28	+10.5	+12	1450	T3	0113	0333	0553	0773
30	100	±10	2	12	17	20	34.5	40	-28	+10.5	+12	1450	T3	0114	0334	0554	0774
30	100	± 5	2	12	17	20	34.5	40	-28	+10.5	+12	1450	T3	0115	0335	0555	0775
30	150	±20	2	18	23	20	34.5	35	-48	+13	+15	1525	T3	0116	0336	0556	0776
30	150	±10	2	18	23	20	34.5	35	-48	+13	+15	1525	T3	0117	0337	0557	0777
30	150	± 5	2	18	23	20	34.5	35	-48	+13	+15	1525	T3	0118	0338	0558	0778
30	300	±20	8	32	31	20	34.5	25	-60	+25	+25	1950	T4	0119	0339	0559	0779
30	300	±10	8	32	31	20	34.5	25	-60	+25	+25	1950	T4	0120	0340	0560	0780

See footnotes at end of table.

MIL-C-39006

Military Style Tantalum Capacitors

MIL-C-39006/22
STYLE CLR79

1/ Rated voltage (+85°C)	Cap.	Cap. tolerance	DC leakage (max) +25°C	DC leakage (max) +85°C & +125°C	Dissipation factor (max)	Derated voltage (+125°C)	Surge voltage (+85°C)	Impedance (max)	Capacitance change at -55°C	Capacitance change at +85°C	Capacitance change at +125°C	2/Max. 85°C 40 kHz ripple current	Case size	Part No. M39006/22-* Failure rate level (%/1,000 hr) M(1.0)	P(0.1)	R(0.01)	S(0.001)
Vdc	uF	%	uA	uA	%	Vdc	Vdc	Ohms	%	%	%	mA rms					
50	5	±20	1	2	3	30	57.5	400	-16	+ 5	+ 6	580	T1	0121	0341	0561	0781
50	5	±10	1	2	3	30	57.5	400	-16	+ 5	+ 6	580	T1	0122	0342	0562	0782
50	5	± 5	1	2	3	30	57.5	400	-16	+ 5	+ 6	580	T1	0123	0343	0563	0783
50	10	±20	1	2	4	30	57.5	250	-24	+ 8	+ 9	715	T1	0124	0344	0564	0784
50	10	±10	1	2	4	30	57.5	250	-24	+ 8	+ 9	715	T1	0125	0345	0565	0785
50	10	± 5	1	2	4	30	57.5	250	-24	+ 8	+ 9	715	T1	0126	0346	0566	0786
50	25	±20	1	5	8	30	57.5	95	-20	+10.5	+12	1005	T2	0127	0347	0567	0787
50	25	±10	1	5	8	30	57.5	95	-20	+10.5	+12	1005	T2	0128	0348	0568	0788
50	25	± 5	1	5	8	30	57.5	95	-20	+10.5	+12	1005	T2	0129	0349	0569	0789
50	47	±20	1	9	11	30	57.5	70	-28	+13	+15	1155	T2	0130	0350	0570	0790
50	47	±10	1	9	11	30	57.5	70	-28	+13	+15	1155	T2	0131	0351	0571	0791
50	47	± 5	1	9	11	30	57.5	70	-28	+13	+15	1155	T2	0132	0352	0572	0792
50	60	±20	2	12	12	30	57.5	45	-16	+10.5	+12	1335	T3	0133	0353	0573	0793
50	60	±10	2	12	12	30	57.5	45	-16	+10.5	+12	1335	T3	0134	0354	0574	0794
50	60	± 5	2	12	12	30	57.5	45	-16	+10.5	+12	1335	T3	0135	0355	0575	0795
50	82	±20	2	16	15	30	57.5	45	-32	+13	+15	1400	T3	0136	0356	0576	0796
50	82	±10	2	16	15	30	57.5	45	-32	+13	+15	1400	T3	0137	0357	0577	0797
50	82	± 5	2	16	15	30	57.5	45	-32	+13	+15	1400	T3	0138	0358	0578	0798
50	160	±20	8	32	17	30	57.5	27	-50	+25	+25	1900	T4	0139	0359	0579	0799
50	160	±10	8	32	17	30	57.5	27	-50	+25	+25	1900	T4	0140	0360	0580	0800
60	4	±20	1	2	2.8	40	69.0	550	-16	+ 5	+ 6	525	T1	0141	0361	0581	0801
60	4	±10	1	2	2.8	40	69.0	550	-16	+ 5	+ 6	525	T1	0142	0362	0582	0802
60	4	± 5	1	2	2.8	40	69.0	550	-16	+ 5	+ 6	525	T1	0143	0363	0583	0803
60	8.2	±20	1	2	4	40	69.0	275	-24	+ 8	+ 9	625	T1	0144	0364	0584	0804
60	8.2	±10	1	2	4	40	69.0	275	-24	+ 8	+ 9	625	T1	0145	0365	0585	0805
60	8.2	± 5	1	2	4	40	69.0	275	-24	+ 8	+ 9	625	T1	0146	0366	0586	0806
60	20	±20	1	5	7	40	69.0	105	-16	+10.5	+12	930	T2	0147	0367	0587	0807
60	20	±10	1	5	7	40	69.0	105	-16	+10.5	+12	930	T2	0148	0368	0588	0808
60	20	± 5	1	5	7	40	69.0	105	-16	+10.5	+12	930	T2	0149	0369	0589	0809
60	39	±20	1	9	10	40	69.0	90	-28	+10.5	+12	1110	T2	0150	0370	0590	0810
60	39	±10	1	9	10	40	69.0	90	-28	+10.5	+12	1110	T2	0151	0371	0591	0811
60	39	± 5	1	9	10	40	69.0	90	-28	+10.5	+12	1110	T2	0152	0372	0592	0812
60	50	±20	2	12	10	40	69.0	50	-16	+10.5	+12	1330	T3	0153	0373	0593	0813
60	50	±10	2	12	10	40	69.0	50	-16	+10.5	+12	1330	T3	0154	0374	0594	0814
60	50	± 5	2	12	10	40	69.0	50	-16	+10.5	+12	1330	T3	0155	0375	0595	0815
60	68	±20	2	16	13	40	69.0	50	-32	+10.5	+12	1365	T3	0156	0376	0596	0816
60	68	±10	2	16	13	40	69.0	50	-32	+10.5	+12	1365	T3	0157	0377	0597	0817
60	68	± 5	2	16	13	40	69.0	50	-32	+10.5	+12	1365	T3	0158	0378	0598	0818
60	140	±20	8	32	16	40	69.0	28	-40	+20	+20	1850	T4	0159	0379	0599	0819
60	140	±10	8	32	16	40	69.0	28	-40	+20	+20	1850	T4	0160	0380	0600	0820
75	3.5	±20	1	2	2.5	50	86.2	650	-16	+ 5	+ 6	525	T1	0161	0381	0601	0821
75	3.5	±10	1	2	2.5	50	86.2	650	-16	+ 5	+ 6	525	T1	0162	0382	0602	0822
75	3.5	± 5	1	2	2.5	50	86.2	650	-16	+ 5	+ 6	525	T1	0163	0383	0603	0823
75	6.8	±20	1	2	3.5	50	86.2	300	-20	+ 8	+ 9	610	T1	0164	0384	0604	0824
75	6.8	±10	1	2	3.5	50	86.2	300	-20	+ 8	+ 9	610	T1	0165	0385	0605	0825
75	6.8	± 5	1	2	3.5	50	86.2	300	-20	+ 8	+ 9	610	T1	0166	0386	0606	0826
75	15	±20	1	5	6	50	86.2	150	-16	+ 8	+ 9	890	T2	0167	0387	0607	0827
75	15	±10	1	5	6	50	86.2	150	-16	+ 8	+ 9	890	T2	0168	0388	0608	0828
75	15	± 5	1	5	6	50	86.2	150	-16	+ 8	+ 9	890	T2	0169	0389	0609	0829
75	33	±20	1	10	10	50	86.2	90	-24	+10.5	+15	1000	T2	0170	0390	0610	0830
75	33	±10	1	10	10	50	86.2	90	-24	+10.5	+15	1000	T2	0171	0391	0611	0831
75	33	± 5	1	10	10	50	86.2	90	-24	+10.5	+15	1000	T2	0172	0392	0612	0832
75	40	±20	2	12	9	50	86.2	60	-16	+10.5	+12	1250	T3	0173	0393	0613	0833
75	40	±10	2	12	9	50	86.2	60	-16	+10.5	+12	1250	T3	0174	0394	0614	0834
75	40	± 5	2	12	9	50	86.2	60	-16	+10.5	+12	1250	T3	0175	0395	0615	0835
75	56	±20	2	17	11	50	86.2	60	-28	+10.5	+15	1335	T3	0176	0396	0616	0836
75	56	±10	2	17	11	50	86.2	60	-28	+10.5	+15	1335	T3	0177	0397	0617	0837
75	56	± 5	2	17	11	50	86.2	60	-28	+10.5	+15	1335	T3	0178	0398	0618	0838
75	110	±20	9	36	12	50	86.2	29	-35	+20	+20	1850	T4	0179	0399	0619	0839
75	110	±10	9	36	12	50	86.2	29	-35	+20	+20	1850	T4	0180	0400	0620	0840

See footnotes at end of table.

MIL-C-39006

Military Style Tantalum Capacitors

MIL-C-39006/22
STYLE CLR79

1/ Rated voltage (+85°C)	Cap.	Cap. tolerance	DC leakage (max) +25°C	DC leakage (max) +85°C & +125°C	Dissipation factor (max)	Derated voltage (+125°C)	Surge voltage (+85°C)	Impedance (max)	Capacitance change at −55°C	Capacitance change at +85°C	Capacitance change at +125°C	2/Max. 85°C 40 kHz ripple current	Case size	Part No. M39006/22-* Failure rate level (%/1,000 hr) M(1.0)	P(0.1)	R(0.01)	S(0.001)
Vdc	uF	%	uA	uA	%	Vdc	Vdc	Ohms	%	%	%	mA rms					
100	2.5	±20	1	2	2	65	115	950	−16	+7	+8	505	T1	0181	0401	0621	0841
100	2.5	±10	1	2	2	65	115	950	−16	+7	+8	505	T1	0182	0402	0622	0842
100	2.5	±5	1	2	2	65	115	950	−16	+7	+8	505	T1	0183	0403	0623	0843
100	4.7	±20	1	2	3	65	115	500	−16	+7	+8	565	T1	0184	0404	0624	0844
100	4.7	±10	1	2	3	65	115	500	−16	+7	+8	565	T1	0185	0405	0625	0845
100	4.7	±5	1	2	3	65	115	500	−16	+7	+8	565	T1	0186	0406	0626	0846
100	11	±20	1	4	5	65	115	200	−16	+8	+8	835	T2	0187	0407	0627	0847
100	11	±10	1	4	5	65	115	200	−16	+8	+8	835	T2	0188	0408	0628	0848
100	11	±5	1	4	5	65	115	200	−16	+8	+8	835	T2	0189	0409	0629	0849
100	22	±20	1	9	7.5	65	115	100	−16	+8	+8	965	T2	0190	0410	0630	0850
100	22	±10	1	9	7.5	65	115	100	−16	+8	+8	965	T2	0191	0411	0631	0851
100	22	±5	1	9	7.5	65	115	100	−16	+8	+8	965	T2	0192	0412	0632	0852
100	30	±20	2	12	7	65	115	80	−16	+8	+8	1240	T3	0193	0413	0633	0853
100	30	±10	2	12	7	65	115	80	−16	+8	+8	1240	T3	0194	0414	0634	0854
100	30	±5	2	12	7	65	115	80	−16	+8	+8	1240	T3	0195	0415	0635	0855
100	43	±20	2	17	8.5	65	115	70	−20	+8	+8	1335	T3	0196	0416	0636	0856
100	43	±10	2	17	8.5	65	115	70	−20	+8	+8	1335	T3	0197	0417	0637	0857
100	43	±5	2	17	8.5	65	115	70	−20	+8	+8	1335	T3	0198	0418	0638	0858
100	86	±20	9	36	10	65	115	30	−25	+15	+15	1800	T4	0199	0419	0639	0859
100	86	±10	9	36	10	65	115	30	−25	+15	+15	1800	T4	0200	0420	0640	0860
125	1.7	±20	1	2	2	85	144	1250	−16	+7	+8	415	T1	0201	0421	0641	0861
125	1.7	±10	1	2	2	85	144	1250	−16	+7	+8	415	T1	0202	0422	0642	0862
125	1.7	±5	1	2	2	85	144	1250	−16	+7	+8	415	T1	0203	0423	0643	0863
125	3.6	±20	1	2	2.7	85	144	600	−16	+7	+8	520	T1	0204	0424	0644	0864
125	3.6	±10	1	2	2.7	85	144	600	−16	+7	+8	520	T1	0205	0425	0645	0865
125	3.6	±5	1	2	2.7	85	144	600	−16	+7	+8	520	T1	0206	0426	0646	0866
125	9	±20	1	5	5	85	144	240	−16	+7	+8	755	T2	0207	0427	0647	0867
125	9	±10	1	5	5	85	144	240	−16	+7	+8	755	T2	0208	0428	0648	0868
125	9	±5	1	5	5	85	144	240	−16	+7	+8	755	T2	0209	0429	0649	0869
125	14	±20	1	7	6	85	144	167	−16	+7	+8	860	T2	0210	0430	0650	0870
125	14	±10	1	7	6	85	144	167	−16	+7	+8	860	T2	0211	0431	0651	0871
125	14	±5	1	7	6	85	144	167	−16	+7	+8	860	T2	0212	0432	0652	0872
125	18	±20	2	9	5	85	144	129	−16	+7	+8	1130	T3	0213	0433	0653	0873
125	18	±10	2	9	5	85	144	129	−16	+7	+8	1130	T3	0214	0434	0654	0874
125	18	±5	2	9	5	85	144	129	−16	+7	+8	1130	T3	0215	0435	0655	0875
125	25	±20	2	13	6	85	144	93	−16	+7	+8	1200	T3	0216	0436	0656	0876
125	25	±10	2	13	6	85	144	93	−16	+7	+8	1200	T3	0217	0437	0657	0877
125	25	±5	2	13	6	85	144	93	−16	+7	+8	1200	T3	0218	0438	0658	0878
125	56	±20	10	40	6.5	85	144	32	−25	+15	+15	1800	T4	0219	0439	0659	0879
125	56	±10	10	40	6.5	85	144	32	−25	+15	+15	1800	T4	0220	0440	0660	0880

Ripple current multipliers vs frequency, temperature, and applied peak voltage.

Frequency of applied ripple	120Hz Temp C				800 Hz Temp C				1 kHz Temp C				10kHz Temp C				40kHz Temp C				100kHz Temp C			
current Ambient still air	<55	85	105	125	<55	85	105	125	<55	85	105	125	<55	85	105	125	<55	85	105	125	<55	85	105	125
% of 85 C rated peak voltage 100%	.60	.39	–	–	.71	.43	–	–	.72	.45	–	–	.88	.55	–	–	1.0	.63	–	–	1.1	.69	–	–
90%	.60	.46	–	–	.71	.55	–	–	.72	.55	–	–	.88	.67	–	–	1.0	.77	–	–	1.1	.85	–	–
80%	.60	.52	.35	–	.71	.62	.42	–	.72	.62	.42	–	.88	.76	.52	–	1.0	.87	.59	–	1.1	.96	.65	–
70%	.60	.58	.44	–	.71	.69	.52	–	.72	.70	.52	–	.88	.85	.64	–	1.0	.97	.73	–	1.1	1.07	.80	–
≤66 ⅔%	.60	.60	.46	.27	.71	.71	.55	.32	.72	.72	.55	.32	.88	.88	.68	.40	1.0	1.0	.77	.45	1.1	1.1	.85	.50

1/Reverse voltage rating at 85°C is 3 VDC and at 125°C is 2 VDC.

2/For ripple current limits at various temperatures, voltages, and frequencies, see table directly above.

*For the optional vibration & shock requirements (i.e., 51G Random Vibration, 80G Sinusoidal Vibration, and 500G Shock) the letter "H" must appear following the four digit dash number.

MIL-C-39006

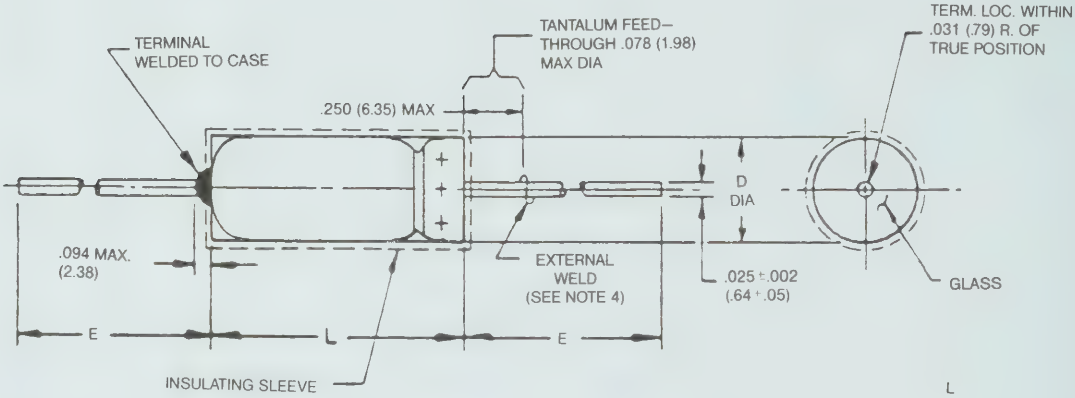
Military Style Tantalum Capacitors

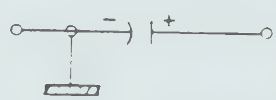
MIL-C-39006/25
STYLE CLR81
APPROVED BY DESC TO THE "H" CHARACTERISTIC

MILITARY CODING SYSTEM

M39006/25-0326

- DASH NUMBER FROM TABLE. For specific value of Capacitance, Capacitance Tolerance, Voltage, Case Size, and Failure Rate Level the table must be consulted
- DETAIL SHEET FOR APPLICABLE STYLE—/25 is CLR 81.
- MIL-C-39006—Generic specification for established reliability non-solid electrolyte tantalum capacitors.





CIRCUIT DIAGRAM

Case Size	Dimensions			
	Basic case		Insulated case	
	L[1] +.031(.79) −.016(.41)	D ±.016(.41)	D max	E ±.250(6.35)
T1	.453(11.51)	.188(4.78)	.219(5.56)	1.500(38.10)
T2	.641(16.28)	.281(7.14)	.312(7.92)	2.250(57.15)
T3	.766(19.46)	.375(9.52)	.406(10.31)	2.250(57.15)
T4	1.062(26.97)	.375(9.52)	.406(10.31)	2.250(57.15)

[1]Length of basic case; sleeving shall be as specified in MIL-C-39006.

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are in parentheses.
3. Metric equivalents are given for general information only.

FIGURE 1. *Style CLR81 capacitors.*

MIL-C-39006/25
STYLE CLR81

See footnotes at end of table.

Rated[1] voltage (+85°C)	Cap.	Cap. tolerance	DC leakage (max) +25°C	DC leakage (max) +85°C & +125°C	Dissipation factor (max)	Derated[1] voltage (+125°C)	Surge voltage (+85°C)	Impedance (max)	Capacitance change at −55°C	Capacitance change at +85°C	Capacitance change at +125°C	Max[2] 85°C 40 kHz ripple current	Case size	Part No. M39006/25-[3] Failure rate level (%/1,000 hr) M(1.0)	P(0.1)	R(0.01)	S(0.001)
volts, dc	μF	percent	μA	μA	percent	volts, dc	volts, dc	ohms	percent	percent	percent	mA rms					
6	220	±20	2	9	50	4	6.9	36	−64	+13	+16	1000	T1	0001−	0089−	0177−	0265−
6	220	±10	2	9	50	4	6.9	36	−64	+13	+16	1000	T1	0002−	0090−	0178−	0266−
6	820	±20	3	14	155	4	6.9	18	−88	+16	+20	1500	T2	0003−	0091−	0179−	0267−
6	820	±10	3	14	155	4	6.9	18	−88	+16	+20	1500	T2	0004−	0092−	0180−	0268−
6	1500	±20	5	20	172	4	6.9	18	−90	+20	+25	1900	T3	0005−	0093−	0181−	0269−
6	1500	±10	5	20	172	4	6.9	18	−90	+20	+25	1900	T3	0006−	0094−	0182−	0270−
6	2200	±20	6	24	170	4	6.9	13	−90	+25	+30	2300	T4	0007−	0095−	0183−	0271−
6	2200	±10	6	24	170	4	6.9	13	−90	+25	+30	2300	T4	0008−	0096−	0184−	0272−
8	180	±20	2	9	41	5	9.2	45	−60	+13	+16	1000	T1	0009−	0097−	0185−	0273−
8	180	±10	2	9	41	5	9.2	45	−60	+13	+16	1000	T1	0010−	0098−	0186−	0274−
8	680	±20	3	14	130	5	9.2	22	−83	+16	+20	1500	T2	0011−	0099−	0187−	0275−
8	680	±10	3	14	130	5	9.2	22	−83	+16	+20	1500	T2	0012−	0100−	0188−	0276−
8	1500	±20	5	20	170	5	9.2	18	−90	+20	+25	1900	T3	0013−	0101−	0189−	0277−
8	1500	±10	5	20	170	5	9.2	18	−90	+20	+25	1900	T3	0014−	0102−	0190−	0278−
8	1800	±20	7	25	138	5	9.2	14	−90	+25	+30	2300	T4	0015−	0103−	0191−	0279−
8	1800	±10	7	25	138	5	9.2	14	−90	+25	+30	2300	T4	0016−	0104−	0192−	0280−
10	150	±20	2	9	34	7	11.5	54	−55	+13	+16	900	T1	0017−	0105−	0193−	0281−
10	150	±10	2	9	34	7	11.5	54	−55	+13	+16	900	T1	0018−	0106−	0194−	0282−
10	560	±20	3	16	106	7	11.5	27	−77	+16	+20	1450	T2	0019−	0107−	0195−	0283−
10	560	±10	3	16	106	7	11.5	27	−77	+16	+20	1450	T2	0020−	0108−	0196−	0284−
10	1200	±20	5	20	137	7	11.5	18	−88	+20	+25	1850	T3	0021−	0109−	0197−	0285−
10	1200	±10	5	20	137	7	11.5	18	−88	+20	+25	1850	T3	0022−	0110−	0198−	0286−
10	1500	±20	7	25	114	7	11.5	15	−88	+25	+30	2300	T4	0023−	0111−	0199−	0287−
10	1500	±10	7	25	114	7	11.5	15	−88	+25	+30	2300	T4	0024−	0112−	0200−	0288−
15	100	±20	2	9	30	10	17.2	72	−44	+13	+16	900	T1	0025−	0113−	0201−	0289−
15	100	±10	2	9	30	10	17.2	72	−44	+13	+16	900	T1	0026−	0114−	0202−	0290−
15	390	±20	3	16	74	10	17.2	31	−66	+16	+20	1450	T2	0027−	0115−	0203−	0291−
15	390	±10	3	16	74	10	17.2	31	−66	+16	+20	1450	T2	0028−	0116−	0204−	0292−
15	820	±20	6	24	111	10	17.2	22	−77	+20	+25	1800	T3	0029−	0117−	0205−	0293−
15	820	±10	6	24	111	10	17.2	22	−77	+20	+25	1800	T3	0030−	0118−	0206−	0294−
15	1000	±20	8	32	92	10	17.2	17	−77	+25	+30	2300	T4	0031−	0119−	0207−	0295−
15	1000	±10	8	32	92	10	17.2	17	−77	+25	+30	2300	T4	0032−	0120−	0208−	0296−
25	68	±20	2	9	22	15	28.8	90	−40	+12	+15	850	T1	0033−	0121−	0209−	0297−
25	68	±10	2	9	22	15	28.8	90	−40	+12	+15	850	T1	0034−	0122−	0210−	0298−
25	270	±20	3	16	55	15	28.8	33	−62	+13	+16	1400	T2	0035−	0123−	0211−	0299−
25	270	±10	3	16	55	15	28.8	33	−62	+13	+16	1400	T2	0036−	0124−	0212−	0300−
25	560	±20	7	28	76	15	28.8	24	−72	+20	+25	1750	T3	0037−	0125−	0213−	0301−
25	560	±10	7	28	76	15	28.8	24	−72	+20	+25	1750	T3	0038−	0126−	0214−	0302−
25	680	±20	8	32	63	15	28.8	19	−72	+25	+30	2100	T4	0039−	0127−	0215−	0303−
25	680	±10	8	32	63	15	28.8	19	−72	+25	+30	2100	T4	0040−	0128−	0216−	0304−
30	56	±20	2	9	22	20	34.5	100	−38	+12	+15	800	T1	0041−	0129−	0217−	0305−
30	56	±10	2	9	22	20	34.5	100	−38	+12	+15	800	T1	0042−	0130−	0218−	0306−
30	220	±20	3	16	42	20	34.5	36	−60	+13	+16	1200	T2	0043−	0131−	0219−	0307−
30	220	±10	3	16	42	20	34.5	36	−60	+13	+16	1200	T2	0044−	0132−	0220−	0308−
30	470	±20	8	32	64	20	34.5	25	−65	+20	+25	1500	T3	0045−	0133−	0221−	0309−
30	470	±10	8	32	64	20	34.5	25	−65	+20	+25	1500	T3	0046−	0134−	0222−	0310−
30	560	±20	9	36	55	20	34.5	20	−65	+25	+30	2000	T4	0047−	0135−	0223−	0311−
30	560	±10	9	36	55	20	34.5	20	−65	+25	+30	2000	T4	0048−	0136−	0224−	0312−
50	33	±20	2	9	12.3	30	57.5	135	−29	+10	+12	700	T1	0049−	0137−	0225−	0313−
50	33	±10	2	9	12.3	30	57.5	135	−29	+10	+12	700	T1	0050−	0138−	0226−	0314−
50	120	±20	4	24	22.5	30	57.5	49	−42	+12	+15	1200	T2	0051−	0139−	0227−	0315−
50	120	±10	4	24	22.5	30	57.5	49	−42	+12	+15	1200	T2	0052−	0140−	0228−	0316−
50	270	±20	8	32	37	30	57.5	29	−46	+20	+25	1450	T3	0053−	0141−	0229−	0317−
50	270	±10	8	32	37	30	57.5	29	−46	+20	+25	1450	T3	0054−	0142−	0230−	0318−
50	330	±20	9	36	38	30	57.5	22	−46	+25	+30	1900	T4	0055−	0143−	0231−	0319−
50	330	±10	9	36	38	30	57.5	22	−46	+25	+30	1900	T4	0056−	0144−	0232−	0320−
60	27	±20	3	12	10.2	40	69.0	144	−24	+10	+12	700	T1	0057−	0145−	0233−	0321−
60	27	±10	3	12	10.2	40	69.0	144	−24	+10	+12	700	T1	0058−	0146−	0234−	0322−
60	100	±20	4	20	19	40	69.0	54	−36	+12	+15	1100	T2	0059−	0147−	0235−	0323−
60	100	±10	4	20	19	40	69.0	54	−36	+12	+15	1100	T2	0060−	0148−	0236−	0324−
60	220	±20	8	32	30	40	69.0	29	−40	+16	+20	1400	T3	0061−	0149−	0237−	0325−
60	220	±10	8	32	30	40	69.0	29	−40	+16	+20	1400	T3	0062−	0150−	0238−	0326−

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Military Style Tantalum Capacitors

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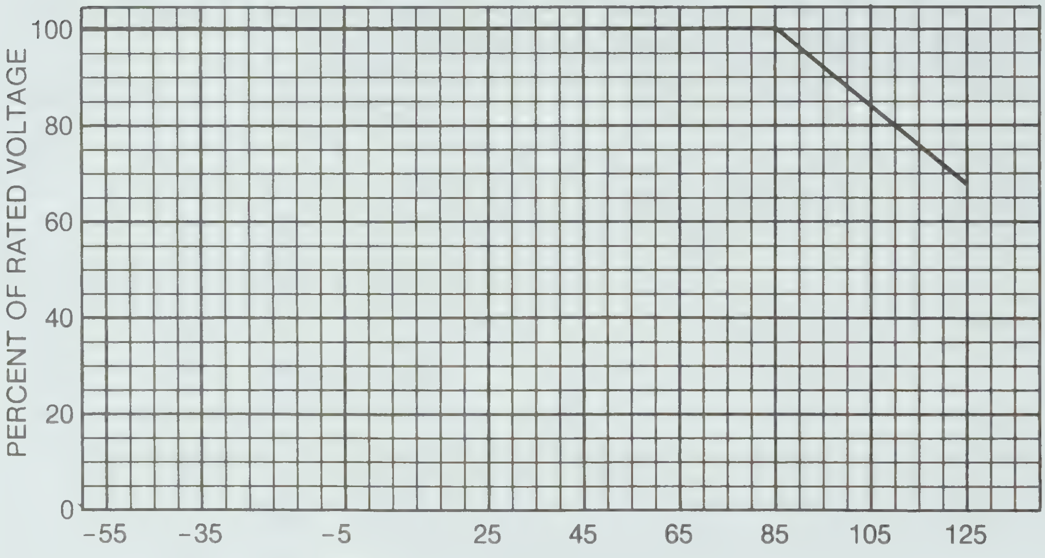
STYLE CLR81

VOLTAGE DERATING WITH TEMPERATURE



3

Tantalum Capacitors

REQUIREMENTS:

Design and construction:
- Dimensions and configuration—See figure 1.
- Case type—Tantalum, tubular, insulated.
- Seal type—Hermetic (glass-to-tantalum seal).
- Terminals—Axial-wire lead:
  - Cathode and anode (type N5 of MIL-STD-1276).
- Rated temperature—−55°C to +85°C, voltage derated to +125°C (see figure 2).
- Rated voltage—See table I.
- Capacitance (Cap.) (nom)—See table I.
- Cap. tolerance—±10 or ±20 percent (see table I).
- FR level—M, P, R, (see table I).

DC leakage (DCL) (max) (at 25°C): See table I.

Cap (nom): Method 305 of MIL-STD-202. See table I.

Dissipation factor (DF) (max): See table I.

Seal: Method 112 or MIL-STD-202, conditions A and C.

Shock (specified pulse): Method 213 of MIL-STD-202, condition I (100g) or condition D (500g), as applicable.

Vibration, high frequency: Method 204 of MIL-STD-202, condition D (20g) or condition H (80g), as applicable.

Random vibration (when applicable): Method 214 of MIL-STD-202, test condition II-K (51g).

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Life at 85°C: Method 108 of MIL-STD-202.
- 2,000-hr (qualification):
  - DCL—See table I.
  - △ Cap.—Within ±10% of initial measurement.
  - DF—See table I.
- 10,000-hr (group B) and extended life:
  - DCL (85°C)—125% (max) of table I value.
  - DCL (25°C)—See table I.
  - △ Cap.—Within +10%, −20% of initial measurement.
  - DF—200% (max) of table I value.
  - DWV—2,000 V dc, min.
  - IR—100 megohms, min.

AC ripple life at 85°C (qualifications and group C):
- Test ripple current—see table I.
- Test voltage—66.67% of rated voltage (see table I).
  - DCL—See table I.
  - △ Cap.—Within ±10% of initial measurement.
  - DF—See table I.

Vacuum life: Not applicable.

Barometric pressure: Method 105 of MIL-STD-202, condition E (150,000 ft).
- Test voltage—Rated voltage.

Resistance to soldering heat: Method 210 of MIL-STD-202, condition B.
- DCL—See table I.
- △ Cap.—Within ±5% of initial measurement.
- DF—See table I.

Marking: In accordance with MIL-C–39006.
- Polarity—Series of plus (+) symbols encircling positive end (see figure 1).

Voltage groups (85°C rated voltage):

I	6 to 15 V inclusive
II	25 to 75 V inclusive
III	100 to 125 V inclusive

Life at 125°C: Method 108 of MIL-STD-202.
- DCL—See table I.
- △ Cap.—Within ±10% of initial measurement.
- DF—See table I.
- DWV—2,000 V dc, min.
- IR—100 megohms, min.
- 10,000-hr (group B):
  - DCL (125°C)—125% (max) of table I value.
  - DCL (25°C)—See table I.
  - △ Cap.—Within +10%, −20% of initial measurement.
  - DF—200% (max) of table I value.
  - DWV—2,000 V dc, min.
  - IR—100 megohms, min.

3

Tantalum Capacitors

MIL-C-39006/25
STYLE CLR81

RIPPLE CURRENT MULTIPLIERS VS FREQUENCY, TEMPERATURE, AND APPLIED PEAK VOLTAGE.

Frequency of applied ripple current		120 Hz				800Hz				1 kHz				10 kHz				40 kHz				100 kHz			
		Temp °C				Temp °C				Temp °C				Temp °C				Temp °C				Temp °C			
Ambient still air		≤55°	85°	105°	125°	<55°	85°	105°	125°	≤55°	85°	105°	125°	<55°	85°	105°	125°	≤55°	85°	105°	125°	≤55°	85°	105°	125°
% of	100%	.60	.39	–	–	.71	.43	–	–	.72	.45	–	–	.88	.55	–	–	1.0	.63	–	–	1.1	.69	–	–
85°C	90%	.60	.46	–	–	.71	.55	–	–	.72	.55	–	–	.88	.67	–	–	1.0	.77	–	–	1.1	.85	–	–
rated	80%	.60	.52	.35	–	.71	.62	.42	–	.72	.62	.42	–	.88	.76	.52	–	1.0	.87	.59	–	1.1	.96	.65	–
peak	70%	.60	.58	.44	–	.71	.69	.52	–	.72	.70	.52	–	.88	.85	.64	–	1.0	.97	.73	–	1.1	1.07	.80	–
voltage	66 2/3%	.60	.60	.46	.27	.71	.71	.55	.32	.72	.72	.55	.32	.88	.88	.68	.40	1.0	1.0	.77	.45	1.1	1.1	.85	.50

NOTES:

1. At 125°C the rated voltage of the capacitors decreases to 66-2/3% of the 85°C rated voltage.
2. The peak of the applied ac ripple voltage plus the applied dc voltage must not exceed the dc voltage rating of the capacitor either forward or reverse.
3. The ripple current listed in table I represents a rating calculated using a maximum internal temperature rise (△T) of 50°C at 40 kHz at 85°C ambient with a maximum peak rated voltage of 66-2/3% of the 85°C peak voltage rating.
4. The maximum allowable internal temperature rise (△T) decreases linearly to a calculated 10°C rise at 125°C ambient.
5. The internal temperature rise is directly proportional to the ESR of the capacitor, and ESR increases with decreasing frequency.

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Thermal shock: Method 107 of MIL-STD-202, condition A (with step 3 at +125°C).
  Number of cycles—300 for qualification and group C—30 for group B.
    DCL—200% (max) of 25°C value of table I for qualification and group C.
    DCL—125% (max) of 25°C value of table I for group B.
    △ Cap.—Within ±5% of initial measurement.
    DF—115% (max) of initial measurement.

Salt spray (corrosion): Method 101 of MIL-STD-202, condition B (48 hrs.).

Solderability: Method 208 of MIL-STD-202.

Terminal strength:
  Pull—Method 211 of MIL-STD-202, condition A.
  Wire-lead bend—In accordance with MIL-C-39006.

Surge voltage: See table I.

Moisture resistance: Method 106 of MIL-STD-202.
    DCL—125% (max) of 25°C value of table I.
    △ Cap.—Within ±8% of initial measurement.
    DF—115% (max) of initial requirement.

Dielectric withstanding voltage (DWV): Method 301 of MIL-STD-202. 2,000 V dc, min.

Insulation resistance (IR): Method 302 of MIL-STD-202, condition B. 100 megohms, min.

Low temperature (storage): Method 502 of MIL-STD-810.
    DCL—See table I.
    △ Cap.—Within ±5% of initial measurement.
    DF—See table I.

Stability at low and high temperatures:
  Step 1 (+25°C):
    DCL—See table I.
    Cap.—Within tolerance of table I value.
    DF—See table I.
  Step 2 (−55°C):
    Imp.—See table I.
    △ Cap.—See table I.
  Step 3 (+25°C):
    DCL—See table I.
    △ Cap.—Within ±5% of step 1 value.
    DF—See table I.
  Step 4 (+85°C):
    DCL—See table I.
    △ Cap.—See table I.
    DF—See table I.
  Step 5 (+125°C):
    DCL—See table I.
    △ Cap.—See table I.
    DF—See table I.
  Step 6 (+25°C):
    DCL—See table I.
    △ Cap.—Within ±5% of step 1 value.
    DF—See table I.

Reverse voltage: As specified in MIL-C-39006.
    DCL—See table I.
    △ Cap.—Within tolerance of table I value.
    DF—See table I.

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Military Style Tantalum Capacitors

MIL-C-39006/25
STYLE CLR81

Rated[1] voltage (+85°C)	Cap.	Cap. tolerance	DC leakage (max) +25°C	DC leakage (max) +85°C & +125°C	Dissipation factor (max)	Derated[1] voltage (+125°C)	Surge voltage (+85°C)	Impedance (max)	Capacitance change at −55°C	Capacitance change at +85°C	Capacitance change at +125°C	Max[2] 85°C 40kHz ripple current	Case size	Part No. M39006/25-[3] Failure rate level (%/1,000 hr) M(1.0)	P(0.1)	R(0.01)	S(0.001)
volts, dc	μF	percent	μA	μA	percent	volts, dc	volts, dc	ohms	percent	percent	percent	mA rms					
60	270	±20	9	36	27.0	40	69.0	23	−45	+20	+25	1850	T4	0063−	0151−	0239−	0327−
60	270	±10	9	36	27.0	40	69.0	23	−45	+20	+25	1850	T4	0064−	0152−	0240−	0328−
75	22	±20	3	12	8.5	50	86.2	157	−19	+10	+12	600	T1	0065−	0153−	0241−	0329−
75	22	±10	3	12	8.5	50	86.2	157	−19	+10	+12	600	T1	0066−	0154−	0242−	0330−
75	82	±20	4	24	15.2	50	86.2	63	−30	+12	+15	1000	T2	0067−	0155−	0243−	0331−
75	82	±10	4	24	15.2	50	86.2	63	−30	+12	+15	1000	T2	0068−	0156−	0244−	0332−
75	180	±20	9	36	24.4	50	86.2	30	−35	+16	+20	1300	T3	0069−	0157−	0245−	0333−
75	180	±10	9	36	24.4	50	86.2	30	−35	+16	+20	1300	T3	0070−	0158−	0246−	0334−
75	220	±20	10	40	37.0	50	86.2	24	−40	+20	+25	1800	T4	0071−	0159−	0247−	0335−
75	220	±10	10	40	37.0	50	86.2	24	−40	+20	+25	1800	T4	0072−	0160−	0248−	0336−
100	10	±20	3	12	4.5	65	115.0	200	−17	+10	+12	800	T1	0073−	0161−	0249−	0337−
100	10	±10	3	12	4.5	65	115.0	200	−17	+10	+12	800	T1	0074−	0162−	0250−	0338−
100	39	±20	5	24	10.4	65	115.0	80	−20	+12	+15	1300	T2	0075−	0163−	0251−	0339−
100	39	±10	5	24	10.4	65	115.0	80	−20	+12	+15	1300	T2	0076−	0164−	0252−	0340−
100	68	±20	10	40	11.3	65	115.0	40	−30	+14	+16	1600	T3	0077−	0165−	0253−	0341−
100	68	±10	10	40	11.3	65	115.0	40	−30	+14	+16	1600	T3	0078−	0166−	0254−	0342−
100	120	±20	12	48	25.0	65	115.0	30	−35	+15	+17	2000	T4	0079−	0167−	0255−	0343−
100	120	±10	12	48	25.0	65	115.0	30	−35	+15	+17	2000	T4	0080−	0168−	0256−	0344−
125	6.8	±20	3	12	6.0	85	144.0	300	−14	+10	+12	700	T1	0081−	0169−	0257−	0345−
125	6.8	±10	3	12	6.0	85	144.0	300	−14	+10	+12	700	T1	0082−	0170−	0258−	0346−
125	27	±20	5	24	7.2	85	144.0	90	−18	+12	+15	1200	T2	0083−	0171−	0259−	0347−
125	27	±10	5	24	7.2	85	144.0	90	−18	+12	+15	1200	T2	0084−	0172−	0260−	0348−
125	47	±20	10	40	7.9	85	144.0	50	−26	+14	+16	1500	T3	0085−	0173−	0261−	0349−
125	47	±10	10	40	7.9	85	144.0	50	−26	+14	+16	1500	T3	0086−	0174−	0262−	0350−
125	82	±20	12	48	17.4	85	144.0	32	−30	+15	+17	1900	T4	0087−	0175−	0263−	0351−
125	82	±10	12	48	17.4	85	144.0	32	−30	+15	+17	1900	T4	0088−	0176−	0264−	0352−

[1]Reverse voltage rating at 85°C is 3 V dc, and at 125°C is 2 V dc.
[2]For ripple current limits at various temperatures, voltages, and frequencies, see table II.
[3]Dash number will include the letter "H" to indicate the optional vibration and shock requirements (i.e., 51 g random vibration, 80 g sinusoidal vibration, and 500 g shock) or "−" will be deleted.

MIL-C-26655B
STYLES CS12 & CS13

MILITARY CODING SYSTEM

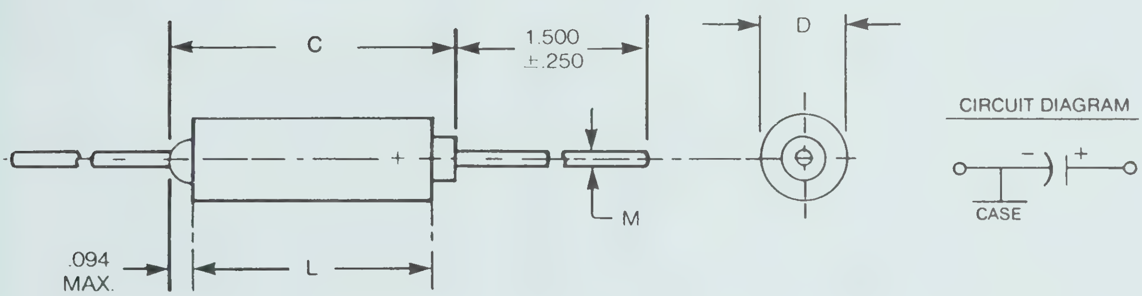
CS12 B B 475 K

- **TOLERANCE** (K)
  K ±10%
  M ±20%
- **CAPACITANCE** (475)
  Nominal capacitance in micro farads.
  First two digits are significant figures, 3rd figure is number of zeros to follow.
  Example: 475 means 4.7 MFD; 476 means 47 MFD.
- **VOLTAGE** (B)
  B = 6, C = 10, D = 15, E = 20, F = 35, G = 50, H = 75, J = 100
- **CHARACTERISTIC** (B)
  B
  -55°C to +85°C at full rated voltage, to +125°C with derated voltage.
- **STYLE** (CS12)

CS12	CS13
Tantalum slug solid electrolyte unsleeved metal case.	Tantalum slug solid electrolyte sleeved metal case.

NOTE: *Military number does not designate case size.* See table *for specific capacitance and voltage rating.*

OUTLINE DRAWING AND DIMENSIONS



Dimensions for style CS12, non-insulated (mm)				
Case Size	C max.	D +0.016 (.41) −0.010 (.25)	L ±0.031 (.79)	M +0.005 −0.001
A	0.422 (10.7)	0.125 (3.2)	0.250 (6.4)	0.020 (.51)
B	0.610 (15.5)	0.175 (4.5)	0.438 (11.1)	0.020 (.51)
C	0.822 (20.9)	0.279 (7.1)	0.650 (16.5)	0.025 (.51)
D	0.922 (23.4)	0.341 (8.7)	0.750 (19.1)	0.025 (.64)

Dimensions for style CS13, insulated (mm)				
Case Size	C max.	D +0.016 (.41) −0.015 (.38)	L ±0.031 (.79)	M +0.005 −0.001
A	0.422 (10.7)	0.135 (3.4)	0.286 (7.3)	0.020 (.51)
B	0.610 (15.5)	0.185 (4.7)	0.474 (12.0)	0.020 (.51)
C	0.822 (20.9)	0.289 (7.3)	0.686 (17.4)	0.025 (.51)
D	0.922 (23.4)	0.351 (8.9)	0.786 (20.0)	0.025 (.64)

NOTE: MIL-C-26655 is a cancelled specification. Current military contracts should order MIL-C-39003. Substitutable parts.

MIL-C-26655B

Military Style Tantalum Capacitors

MIL-C-26655B
STYLES CS12 & CS13

Type designation 1/	DC rated voltage	Capacitance	Cap. Tolerance	DC leakage at: +25°C	DC leakage at: +85°C	DC leakage at: +125°C	Dissipation factor at: +25°C -55°C	Dissipation factor at: +85°C +125°C	Case size	Dash Number CS12	Dash Number CS13
	volts	uf		ua	ua	ua	percent	percent			
CS1-BB565K	6	5.6	K	.5	5	6.3	3	4	A	0001	0002
CS1-BB685K	6	6.8	K	.5	5	6.3	6	6	A	0003	0004
CS1-BB685M	6	6.8	M	.5	5	6.3	6	6	A	0005	0006
CS1-BB476K	6	47	K	3	30	38	6	6	B	0007	0008
CS1-BB476M	6	47	M	3	30	38	6	6	B	0009	0010
CS1-BB566K	6	56	K	3	30	38	6	6	B	0011	0012
CS1-BB157K	6	150	K	9	90	113	8	8	C	0013	0014
CS1-BB157M	6	150	M	9	90	113	8	8	C	0015	0016
CS1-BB187K	6	180	K	11	110	138	8	8	C	0017	0018
CS1-BB277K	6	270	K	13	130	163	8	8	D	0019	0020
CS1-BB337K	6	330	K	15	150	188	8	8	D	0021	0022
CS1-BB337M	6	330	M	15	150	188	8	8	D	0023	0024
CS1-BC395K	10	3.9	K	.6	6	7.5	3	4	A	0025	0026
CS1-BC475K	10	4.7	K	.7	7	8.8	3	4	A	0027	0028
CS1-BC475M	10	4.7	M	.7	7	8.8	3	4	A	0029	0030
CS1-BC276K	10	27	K	4	40	50	6	6	B	0031	0032
CS1-BC336K	10	33	K	5	50	63	6	6	B	0033	0034
CS1-BC336M	10	33	M	5	50	63	6	6	B	0035	0036
CS1-BC396K	10	39	K	5	50	63	6	6	B	0037	0038
CS1-BC826K	10	82	K	8	80	100	6	6	C	0039	0040
CS1-BC107K	10	100	K	10	100	125	8	8	C	0041	0042
CS1-BC107M	10	100	M	10	100	125	8	8	C	0043	0044
CS1-BC127K	10	120	K	12	120	150	8	8	C	0045	0046
CS1-BC187K	10	180	K	18	180	226	8	8	D	0047	0048
CS1-BC227K	10	220	K	20	200	250	8	8	D	0049	0050
CS1-BC227M	10	220	M	20	200	250	8	8	D	0051	0052
CS1-BD275K	15	2.7	K	.6	6	7.5	3	4	A	0053	0054
CS1-BD335K	15	3.3	K	.8	8	10	3	4	A	0055	0056
CS1-BD335M	15	3.3	M	.8	8	10	3	4	A	0057	0058
CS1-BD186K	15	18	K	3.5	35	44	6	6	B	0059	0060
CS1-BD226K	15	22	K	4	40	50	6	6	B	0061	0062
CS1-BD226M	15	22	M	4	40	50	6	6	B	0063	0064
CS1-BD566K	15	56	K	8	80	100	6	6	C	0065	0066
CS1-BD686K	15	68	K	10	100	125	6	6	C	0067	0068
CS1-BD686M	15	68	M	10	100	125	6	6	C	0069	0070
CS1-BD127K	15	120	K	18	180	226	8	8	D	0071	0072
CS1-BD157K	15	150	K	20	200	250	8	8	D	0073	0074
CS1-BD157M	15	150	M	20	200	250	8	8	D	0075	0076
CS1-BE125K	20	1.2	K	.6	6	7.5	3	4	A	0077	0078
CS1-BE155K	20	1.5	K	.6	6	7.5	3	4	A	0079	0080
CS1-BE155M	20	1.5	M	.6	6	7.5	3	4	A	0081	0082
CS1-BE185K	20	1.8	K	.6	6	7.5	3	4	A	0083	0084
CS1-BE225K	20	2.2	K	.8	8	10	3	4	A	0085	0086
CS1-BE225M	20	2.2	M	.8	8	10	3	4	A	0087	0088

1/ Complete type designation will include additional symbols to indicate style, and where applicable, capacitance tolerance.

MIL-C-26655B
STYLES CS12 & CS13

Type designation 1/	DC rated voltage	Capacitance	Cap. Tolerance	DC leakage at: +25°C	DC leakage at: +85°C	DC leakage at: +125 C	Dissipation factor at: +25°C -55°C	Dissipation factor at: +85°C +125°C	Case size	Dash Number CS12	Dash Number CS13
	volts	uf		ua	ua	ua	percent	percent			
CS1-BE825K	20	8.2	K	2	20	25	6	6	B	0089	0090
CS1-BE106K	20	10	K	3	30	38	6	6	B	0091	0092
CS1-BE106M	20	10	M	3	30	38	6	6	B	0093	0094
CS1-BE126K	20	12	K	3.5	35	44	6	6	B	0095	0096
CS1-BE156K	20	15	K	4	40	50	6	6	B	0097	0098
CS1-BE156M	20	15	M	4	40	50	6	6	B	0099	0100
CS1-BE276K	20	27	K	5	50	63	6	6	C	0101	0102
CS1-BE336K	20	33	K	7	70	88	6	6	C	0103	0104
CS1-BE336M	20	33	M	7	70	88	6	6	C	0105	0106
CS1-BE396K	20	39	K	8	80	100	6	6	C	0107	0108
CS1-BE476K	20	47	K	9	90	113	6	6	C	0109	0110
CS1-BE476M	20	47	M	9	90	113	6	6	C	0111	0112
CS1-BE566K	20	56	K	11	110	138	6	6	D	0113	0114
CS1-BE686K	20	68	K	14	140	175	6	6	D	0115	0116
CS1-BE686M	20	68	M	14	140	175	6	6	D	0117	0118
CS1-BE826K	20	82	K	16	160	200	6	6	D	0119	0120
CS1-BE107K	20	100	K	20	200	250	8	8	D	0121	0122
CS1-BE107M	20	100	M	20	200	250	8	8	D	0123	0124
CS1-BF334K	35	0.33	K	.5	5	6.3	3	4	A	0125	0126
CS1-BF334M	35	0.33	M	.5	5	6.3	3	4	A	0127	0128
CS1-BF394K	35	0.39	K	.5	5	6.3	3	4	A	0129	0130
CS1-BF474K	35	0.47	K	.5	5	6.3	3	4	A	0131	0132
CS1-BF474M	35	0.47	M	.5	5	6.3	3	4	A	0133	0134
CS1-BF564K	35	0.56	K	.5	5	6.3	3	4	A	0135	0136
CS1-BF684K	35	0.68	K	.5	5	6.3	3	4	A	0137	0138
CS1-BF684M	35	0.68	M	.5	5	6.3	3	4	A	0139	0140
CS1-BF824K	35	0.82	K	.6	6	7.5	3	4	A	0141	0142
CS1-BF105K	35	1.0	K	.6	6	7.5	3	4	A	0143	0144
CS1-BF105M	35	1.0	M	.6	6	7.5	3	4	A	0145	0146
CS1-BF125K	35	1.2	K	.6	6	7.5	3	4	B	0147	0148
CS1-BF155K	35	1.5	K	.8	8	10	3	4	B	0149	0150
CS1-BF155M	35	1.5	M	.8	8	10	3	4	B	0151	0152
CS1-BF185K	35	1.8	K	1	10	13	3	4	B	0153	0154
CS1-BF225K	35	2.2	K	1.2	12	15	3	4	B	0155	0156
CS1-BF225M	35	2.2	M	1.2	12	15	3	4	B	0157	0158
CS1-BF275K	35	2.7	K	1.5	15	19	3	4	B	0159	0160
CS1-BF335K	35	3.3	K	2	20	25	3	4	B	0161	0162
CS1-BF335M	35	3.3	M	2	20	25	3	4	B	0163	0164
CS1-BF395K	35	3.9	K	2.5	25	32	3	4	B	0165	0166
CS1-BF475K	35	4.7	K	2.5	25	32	3	4	B	0167	0168
CS1-BF475M	35	4.7	M	2.5	25	32	3	4	B	0169	0170
CS1-BF565K	35	5.6	K	2.5	25	32	3	4	B	0171	0172
CS1-BF685K	35	6.8	K	3	30	38	6	6	B	0173	0174
CS1-BF685M	35	6.8	M	3	30	38	6	6	B	0175	0176
CS1-BF825K	35	8.2	K	3	30	38	6	6	C	0177	0178

1/ Complete type designation will include additional symbols to indicate style, and where applicable, capacitance tolerance.

MIL-C-26655B
Military Style Tantalum Capacitors

3 Tantalum Capacitors

MIL-C-26655B
STYLES CS12 & CS13

Type designation 1/	DC rated voltage	Capacitance	Cap. Tolerance	DC leakage at: +25 C	DC leakage at: +85°C	DC leakage at: +125°C	Dissipation factor at: +25°C -55°C	Dissipation factor at: +85°C +125°C	Case size	Dash Number CS12	Dash Number CS13
	volts	uf		ua	ua	ua	percent	percent			
CS1-BF106K	35	10	K	4	40	50	6	6	C	0179	0180
CS1-BF106M	35	10	M	4	40	50	6	6	C	0181	0182
CS1-BF126K	35	12	K	4	40	50	6	6	C	0183	0184
CS1-BF156K	35	15	K	5	50	63	6	6	C	0185	0186
CS1-BF156M	35	15	M	5	50	63	6	6	C	0187	0188
CS1-BF186K	35	18	K	6	60	75	6	6	C	0189	0190
CS1-BF226K	35	22	K	8	80	100	6	6	C	0191	0192
CS1-BF226M	35	22	M	8	80	100	6	6	C	0193	0194
CS1-BF276K	35	27	K	9	90	113	6	6	D	0195	0196
CS1-BF336K	35	33	K	11	110	138	6	6	D	0197	0198
CS1-BF336M	35	33	M	11	110	138	6	6	D	0199	0200
CS1-BF396K	35	39	K	14	140	175	6	6	D	0201	0202
CS1-BF476K	35	47	K	16	160	200	6	6	D	0203	0204
CS1-BF476M	35	47	M	16	160	200	6	6	D	0205	0206
CS1-BG105K	50	1	K	.8	8	10	3	4	A	0207	0208
CS1-BG105M	50	1	M	.8	8	10	3	4	A	0209	0210
CS1-BG125K	50	1.2	K	.9	9	11	3	4	B	0211	0212
CS1-BG155K	50	1.5	K	1.2	12	15	3	4	B	0213	0214
CS1-BG155M	50	1.5	M	1.2	12	15	3	4	B	0215	0216
CS1-BG185K	50	1.8	K	1.4	14	18	3	4	B	0217	0218
CS1-BG225K	50	2.2	K	1.7	17	22	3	4	B	0219	0220
CS1-BG225M	50	2.2	M	1.7	17	22	3	4	B	0221	0222
CS1-BG275K	50	2.7	K	2	20	25	3	4	B	0223	0224
CS1-BG335K	50	3.3	K	2.5	25	32	3	4	B	0225	0226
CS1-BG335M	50	3.3	M	2.5	25	32	3	4	B	0227	0228
CS1-BG395K	50	3.9	K	3	30	38	3	4	B	0229	0230
CS1-BG475K	50	4.7	K	3.5	35	44	3	4	B	0231	0232
CS1-BG475M	50	4.7	M	3.5	35	44	3	4	B	0233	0234
CS1-BG565K	50	5.6	K	4.5	45	56	3	4	C	0235	0236
CS1-BG685K	50	6.8	K	4.5	45	56	6	6	C	0237	0238
CS1-BG685M	50	6.8	M	4.5	45	56	6	6	C	0239	0240
CS1-BG825K	50	8.2	K	5	50	63	6	6	C	0241	0242
CS1-BG106K	50	10	K	5	50	63	6	6	C	0243	0244
CS1-BG106M	50	10	M	5	50	63	6	6	C	0245	0246
CS1-BG126K	50	12	K	6	60	75	6	6	C	0247	0248
CS1-BG156K	50	15	K	8	80	100	6	6	C	0249	0250
CS1-BG156M	50	15	M	8	80	100	6	6	C	0251	0252
CS1-BG186K	50	18	K	9	90	113	6	6	C	0253	0254
CS1-BG226K	50	22	K	11	110	138	6	6	D	0255	0256
CS1-BG226M	50	22	M	11	110	138	6	6	D	0257	0258

1/ Complete type designation will include additional symbols to indicate style, and where applicable, capacitance tolerance.

MIL-C-26655B
STYLES CS12 & CS13

Type designation 1/	DC rated voltage	Capacitance	Cap. Tolerance	DC leakage at:			Dissipation factor at:		Case size	Dash Number	
				+25°C	+85°C	+125°C	+25°C -55°C	+85°C +125°C		CS12	CS13
	volts	uf		ua	ua	ua	percent	percent			
CS1-BH104K	75	.10	K	.5	5	6.3	3	4	A	0259	0260
CS1-BH104M	75	.10	M	.5	5	6.3	3	4	A	0261	0262
CS1-BH124K	75	.12	K	.5	5	6.3	3	4	A	0263	0264
CS1-BH154K	75	.15	K	.5	5	6.3	3	4	A	0265	0266
CS1-BH154M	75	.15	M	.5	5	6.3	3	4	A	0267	0268
CS1-BH184K	75	.18	K	.5	5	6.3	3	4	A	0269	0270
CS1-BH224K	75	.22	K	.5	5	6.3	3	4	A	0271	0272
CS1-BH224M	75	.22	M	.5	5	6.3	3	4	A	0273	0274
CS1-BH274K	75	.27	K	.5	5	6.3	3	4	A	0275	0276
CS1-BH334K	75	.33	K	.5	5	6.3	3	4	A	0277	0278
CS1-BH334M	75	.33	M	.5	5	6.3	3	4	A	0279	0280
CS1-BH394K	75	.39	K	.5	5	6.3	3	4	A	0281	0282
CS1-BH474K	75	.47	K	.5	5	6.3	3	4	A	0283	0284
CS1-BH474M	75	.47	M	.5	5	6.3	3	4	A	0285	0286
CS1-BH564K	75	.56	K	.5	5	6.3	3	4	A	0287	0288
CS1-BH684K	75	.68	K	.5	5	6.3	3	4	A	0289	0290
CS1-BH684M	75	.68	M	.5	5	6.3	3	4	A	0291	0292
CS1-BH824K	75	.82	K	.5	5	6.3	3	4	B	0293	0294
CS1-BH105K	75	1.0	K	.5	5	6.3	3	4	B	0295	0296
CS1-BH105M	75	1.0	M	.5	5	6.3	3	4	B	0297	0298
CS1-BH125K	75	1.2	K	.5	5	6.3	3	4	B	0299	0300
CS1-BH155K	75	1.5	K	1.0	10	13	3	4	B	0301	0302
CS1-BH155M	75	1.5	M	1.0	10	13	3	4	B	0303	0304
CS1-BH185K	75	1.8	K	1.0	10	13	3	4	B	0305	0306
CS1-BH225K	75	2.2	K	1.5	15	19	3	4	B	0307	0308
CS1-BH225M	75	2.2	M	1.5	15	19	3	4	B	0309	0310
CS1-BH275K	75	2.7	K	1.5	15	19	3	4	B	0311	0312
CS1-BH335K	75	3.3	K	2	20	25	3	4	B	0313	0314
CS1-BH335M	75	3.3	M	2	20	25	3	4	B	0315	0316
CS1-BH395K	75	3.9	K	2	20	25	3	4	B	0317	0318
CS1-BH475K	75	4.7	K	6	60	75	3	4	C	0319	0320
CS1-BH475M	75	4.7	M	6	60	75	3	4	C	0321	0322
CS1-BH565K	75	5.6	K	6	60	75	3	4	C	0323	0324
CS1-BH685K	75	6.8	K	10	100	125	6	6	C	0325	0326
CS1-BH685M	75	6.8	M	10	100	125	6	6	C	0327	0328
CS1-BH825K	75	8.2	K	10	100	125	6	6	C	0329	0330
CS1-BH106K	75	10	K	10	100	125	6	6	C	0331	0332
CS1-BH106M	75	10	M	10	100	125	6	6	C	0333	0334
CS1-BH126K	75	12	K	10	100	125	6	6	D	0335	0336
CS1-BH156K	75	15	K	14	140	175	6	6	D	0337	0338
CS1-BH156M	75	15	M	14	140	175	6	6	D	0339	0340

1/ Complete type designation will include additional symbols to indicate style, and where applicable, capacitance tolerance.

MIL-C-26655B
Military Style Tantalum Capacitors

MIL-C-26655B
STYLES CS12 & CS13

Type designation 1/	DC rated voltage	Capacitance	Cap. Tolerance	DC leakage at: +25°C	DC leakage at: +85°C	DC leakage at: +125°C	Dissipation factor at: +25°C -55°C	Dissipation factor at: +85°C +125°C	Case size	Dash Number CS12	Dash Number CS13
	volts	uf		ua	ua	ua	percent	percent			
CS1-BJ472K	100	.0047	K	.5	5	6.3	3	4	A	0341	0342
CS1-BJ472M	100	.0047	M	.5	5	6.3	3	4	A	0343	0344
CS1-BJ562K	100	.0056	K	.5	5	6.3	3	4	A	0345	0346
CS1-BJ682K	100	.0068	K	.5	5	6.3	3	4	A	0347	0348
CS1-BJ682M	100	.0068	M	.5	5	6.3	3	4	A	0349	0350
CS1-BJ822K	100	.0082	K	.5	5	6.3	3	4	A	0351	0352
CS1-BJ103K	100	.01	K	.5	5	6.3	3	4	A	0353	0354
CS1-BJ103M	100	.01	M	.5	5	6.3	3	4	A	0355	0356
CS1-BJ123K	100	.012	K	.5	5	6.3	3	4	A	0357	0358
CS1-BJ153K	100	.015	K	.5	5	6.3	3	4	A	0359	0360
CS1-BJ153M	100	.015	M	.5	5	6.3	3	4	A	0361	0362
CS1-BJ183K	100	.018	K	.5	5	6.3	3	4	A	0363	0364
CS1-BJ223K	100	.022	K	.5	5	6.3	3	4	A	0365	0366
CS1-BJ223M	100	.022	M	.5	5	6.3	3	4	A	0367	0368
CS1-BJ273K	100	.027	K	.5	5	6.3	3	4	A	0369	0370
CS1-BJ333K	100	.033	K	.5	5	6.3	3	4	A	0371	0372
CS1-BJ333M	100	.033	M	.5	5	6.3	3	4	A	0373	0374
CS1-BJ393K	100	.039	K	.5	5	6.3	3	4	A	0375	0376
CS1-BJ473K	100	.047	K	.5	5	6.3	3	4	A	0377	0378
CS1-BJ473M	100	.047	M	.5	5	6.3	3	4	A	0379	0380
CS1-BJ563K	100	.056	K	.5	5	6.3	3	4	A	0381	0382
CS1-BJ683K	100	.068	K	.5	5	6.3	3	4	A	0383	0384
CS1-BJ683M	100	.068	M	.5	5	6.3	3	4	A	0385	0386
CS1-BJ823K	100	.082	K	.5	5	6.3	3	4	A	0387	0388
CS1-BJ104K	100	.1	K	.5	5	6.3	3	4	A	0389	0390
CS1-BJ104M	100	.1	M	.5	5	6.3	3	4	A	0391	0392
CS1-BJ124K	100	.12	K	.5	5	6.3	3	4	A	0393	0394
CS1-BJ154K	100	.15	K	.5	5	6.3	3	4	A	0395	0396
CS1-BJ154M	100	.15	M	.5	5	6.3	3	4	A	0397	0398
CS1-BJ184K	100	.18	K	.5	5	6.3	3	4	A	0399	0400
CS1-BJ224K	100	.22	K	.5	5	6.3	3	4	A	0401	0402
CS1-BJ224M	100	.22	M	.5	5	6.3	3	4	A	0403	0404
CS1-BJ274K	100	.27	K	.5	5	6.3	3	4	A	0405	0406
CS1-BJ334K	100	.33	K	.5	5	6.3	3	4	A	0407	0408
CS1-BJ334M	100	.33	M	.5	5	6.3	3	4	A	0409	0410
CS1-BJ394K	100	.39	K	.5	5	6.3	3	4	A	0411	0412
CS1-BJ474K	100	.47	K	.5	5	6.3	3	4	A	0413	0414
CS1-BJ474M	100	.47	M	.5	5	6.3	3	4	A	0415	0416
CS1-BJ564K	100	.56	K	.5	5	6.3	3	4	A	0417	0418
CS1-BJ684K	100	.68	K	.5	5	6.3	3	4	B	0419	0420
CS1-BJ684M	100	.68	M	.5	5	6.3	3	4	B	0421	0422
CS1-BJ824K	100	.82	K	.5	5	6.3	3	4	B	0423	0424
CS1-BJ105K	100	1.0	K	.5	5	6.3	3	4	B	0425	0426
CS1-BJ105M	100	1.0	M	.5	5	6.3	3	4	B	0427	0428
CS1-BJ125K	100	1.2	K	.5	5	6.3	3	4	B	0429	0430
CS1-BJ155K	100	1.5	K	1.0	10	13	3	4	B	0431	0432
CS1-BJ155M	100	1.5	M	1.0	10	13	3	4	B	0433	0434
CS1-BJ185K	100	1.8	K	1.0	10	13	3	4	B	0435	0436
CS1-BJ225K	100	2.2	K	1.5	15	19	3	4	B	0437	0438
CS1-BJ225M	100	2.2	M	1.5	15	19	3	4	B	0439	0440
CS1-BJ275K	100	2.7	K	1.5	15	19	3	4	B	0441	0442

1/ Complete type designation will include additional symbols to indicate style, and where applicable, capacitance tolerance.

DESIGN AND CONSTRUCTION

Each established reliability capacitor consists of a highly purified sintered tantalum anode body utilizing an electrolytically formed oxide dielectric, and a solid electrolyte, enclosed in a hermetically sealed metal case with axial leads. This construction will enable the capacitor to withstand the most stringent environmental requirements.

CASE INSULATION

Case insulation of Style CSR capacitor will not soften or creep at the high ambient temperature. Insulation shall possess a minimum dielectric strength of 2000 VDC and insulation resistance of 1000 megohms minimum.

TERMINALS

Leads are the solid conductor type with lengths and diameters specified in table. Material is Type N4 to MIL-STD-1276 electro tin plated to provide coverages and solderability as specified in MIL-STD-202. method 208. The tin content of the coating does not exceed 70 percent. N5 (Hot Solder Dipped) leads are an option.

Each lead shall withstand five bends and five twists per method 211 of MIL-STD-202, without loosening, breaking, or showing other permanent damage. One bend consists of rotating the capacitor body 90° from vertical to horizontal and return with a three (3) pound weight attached to the lead. One twist is defined as one 360° rotation of the lead about its own axis in a period not to exceed 5 seconds.

D.C. LEAKAGE

D.C. leakage shall be measured using the dc rated voltage at ±2 percent at the applicable test temperature, after a maximum electrification period of 5 minutes. A 1,000-ohm resistor shall be placed in series with the capacitor to limit the charging current. A steady source of power, such as a regulated power supply shall be used. Measurement accuracy shall be within ±2 percent or 0.02 microampere (ua), whichever is greater.

CAPACITANCE

Capacitors shall be tested in accordance with method 305 of MIL-STD-202. The following details shall apply:
(a) Test frequency — 120 ± 5 Hertz (cycles per second).
(b) Limit of accuracy — Measurement accuracy shall be within ±2 percent of the reading.
(c) Magnitude of polarizing voltage — Maximum dc bias shall be 2.2 volts for all ac measurements. The magnitude of the ac voltage shall be limited to 1.0 volts rms.

DISSIPATION FACTOR

The dissipation factor of each capacitor shall be measured at a frequency of 120 ± 5 Hertz (Hz) by means of a polarized capacitance bridge. The bridge shall provide a dial reading accuracy of 0.1 percent dissipation factor and a measuring accuracy of ± 2 percent of the measured dissipation factor plus 0.1 percent.

SHOCK, MEDIUM IMPACT

Capacitors shall be tested in accordance with method 205 of MIL-STD-202. The following details and exceptions shall apply:
(a) Special mounting means — Capacitors shall be rigidly mounted on a mounting fixture by the body. Leads shall be secured to rigidly supported terminals, so spaced that the length of each lead from the capacitor is approximately ⅜ inch when measured from the edge of the supporting terminal. Leads shall be within 30 degrees of being parallel. When securing leads, care shall be taken to avoid pinching the leads.
(b) Test condition letter — C (30-inch drop).
(c) Measurements and electrical loading during shock — during the test, observations shall be made to determine intermittent contact or arcing or open or short-circuiting. Detecting equipment shall be sufficiently sensitive to detect any interruption with a duration of 0.5 ms. The dc rated voltage shall be applied to the capacitors during the test.

When capacitors are tested as specified there shall be no intermittent contacts of 0.5 milliseconds (ms) or greater duration, or arcing or other indication of breakdown, nor shall there by any open- or short-circuiting or evidence of mechanical damage.

VIBRATION, HIGH FREQUENCY

Capacitors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:
(a) Mounting of specimens — Capacitors shall be securely mounted by their leads and by their bodies by supplementary mounting means.
(b) Electrical-load conditions — During the test, the specified dc rated voltage shall be applied to the capacitors.
(c) Test condition letter — D (20G's).
(d) Duration and direction of motion — 4 hours in each of two mutually perpendicular directions (total of 8 hours), one parallel and the other perpendicular to the cylindrical axis.
(e) Measurements during vibration — During the last cycle, an electrical measurement shall be made to determine intermittent operation or open- or short-circuiting. Observations shall also be made to determine intermittent contact or arcing or open- or short-circuiting. Detecting equipment shall be sufficiently sensitive to detect any interruption with a duration of 0.5 ms, or greater.

When capacitors are tested as specified, there shall be no intermittent contacts of 0.5 ms or greater duration, or arcing or other indication of breakdown, nor shall there be any open- or short-circuiting or evidence of mechanical damage.

SALT SPRAY (Corrosion)

Capacitors shall be tested in accordance with method 101 of MIL-STD-202. The following details and exception shall apply:
(a) Applicable salt solution — 5 percent.
(b) Test condition letter — B (48 hours).

When capacitors are tested as specified, there shall be no harmful corrosion, and at least 90 percent of any exposed metal surface of the capacitor shall be unaffected. In addition, there shall be not more than 10 percent corrosion of the terminal surface. There shall be no unwrapping or mechanical damage to insulating sleeves. The marking shall remain legible.

THERMAL SHOCK AND IMMERSION

THERMAL SHOCK: Capacitors shall be tested in accordance with method 107 of MIL-STD-202. The following details and exceptions shall apply:
(a) Conditioning prior to first cycle — 15 minutes at the inspection conditions specified in MIL-STD-202.
(b) Test condition letter — B.
(c) Measurements before and after cycling — Not applicable.

IMMERSION: Following temperature cycling, capacitors shall be tested in accordance with method 104 of MIL-STD-202. The following details and exceptions shall apply:
(a) Test condition letter — B.
(b) Measurements after final cycle — Within 30 minutes after removal from the final immersion bath, the dc leakage, capacitance, and dissipation factor shall be measured as specified above.
(c) Examination after test — Capacitors shall be visually examined for evidence of corrosion, mechanical damage, and obliteration of marking.

When tested as specified, capacitors shall meet the following requirements:

DC leakage — Shall not exceed the requirement specified in table for specific rating.

Capacitance — Shall change not more than ±3 percent from the initial value.

Dissipation factor — Shall not exceed the requirement specified in table for specific rating.

MIL-C-39003

RADIOGRAPHIC INSPECTION

Capacitors shall be X-rayed in one plane at 90-degree rotation perpendicular to their longitudinal axis for evidence of improperly made connections, misalignment of slugs and seals or eyelets, substandard soldering or structural weakness, or solder particles or slivers attached to one end. The X-rays thus obtained shall be retained by the manufacturer. X-rays shall be available for each lot produced to allow a review at the discretion of the procuring activity. The magnification during visual examination shall be 2 power, minimum. If number of defectives exceed the allowable limit, X-ray shall be performed in two planes for all subsequent lots. Manufacturer may return to one plane testing when three sequential lots meet specification limits.

When capacitors are tested as specified, radiographic inspection shall disclose no evidence of improperly made connections, misalignment of slugs and seals or eyelets, substandard soldering or structural weakness, or solder particles or slivers attached to one end.

MOISTURE RESISTANCE

Capacitors shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

(a) Mounting — Except during examination and measurements, capacitors shall be securely fastened by the body.
(b) Initial measurements — Not applicable.
(c) Polarization and loading voltages — Not applicable.
(d) Final measurements — After the final cycle and within 2 to 6 hours after removal of the capacitors from the humidity chamber, the dc leakage, capacitance, and dissipation factor shall be measured, at the initial inspection conditions specified.
(e) Examinations after test — Capacitors shall be visually examined for evidence of corrosion, mechanical damage, and obliteration of marking.

When tested as specified, capacitors shall meet the following requirements.

DC leakage — Shall not exceed the requirement specified.
Capacitance — Shall change not more than ±2% from initial value.
Dissipation factor — Shall not exceed the requirement specified.
Visual examination — There shall be no evidence of mechanical damage and the marking shall remain legible.

STABILITY AT LOW AND HIGH TEMPERATURE

Capacitors will meet the following requirements as applicable.

Step 1 (+25°C):
DC leakage — Shall not exceed the applicable value specified.
Capacitance — Shall be within the tolerance specified in the type designation specified.
Dissipation factor — Shall not exceed the applicable value specified.

Step 2 (-55°C):
Capacitance — Shall change not more than ±10% from the step 1 measured value.
Dissipation factor — Shall not exceed the applicable value specified.

Step 3 (+25°C):
DC leakage — Shall not exceed the applicable value specified.
Capacitance — Shall change not more than ±2 percent from the step 1 measured value.
Dissipation factor — Shall not exceed the applicable value specified.

Step 4 (+85°C):
DC leakage — Shall not exceed the applicable value specified.
Capacitance — Shall change not more than ±8% from the step 1 measured value.
Dissipation factor — Shall not exceed the applicable value specified.

Step 5 (+25°C):
DC leakage — Shall not exceed the applicable value specified.
Capacitance — Shall change not more than ±2 percent from the step 1 measured value.
Dissipation factor — Shall not exceed the applicable value specified.

SURGE VOLTAGE

Capacitors shall be subjected to 1,000 cycles of the applicable surge voltage. The ambient temperature during cycling shall be +85°C. Each cycle shall consist of a 30-second surge voltage application followed by a 30-second discharge period. Voltage application shall be made through a resistor of 33 ohms. The tolerance of the resistor shall be ±5 percent. Each surge voltage cycle shall be performed in such a manner that the capacitor is shorted terminal to terminal through a copper bar, or an equivalent low resistance at the end of the 30-second application. An alternate method of shorting the capacitors is discharge through the same resistance that is utilized for charging. After the final cycle, the capacitors shall be stabilized at the inspection conditions, and the dc leakage, capacitance, and dissipation factor shall be measured.

When tested as specified, capacitors shall meet the following requirements:

DC leakage — Shall not exceed the requirement specified.
Capacitance — Shall change not more than ±2% from initial value.
Dissipation factor — Shall not exceed the requirement specified.

WEIBULL AND EXPONENTIAL DISTRIBUTIONS

Exponential lifetest devices (dash numbers) are available for existing equipment designs in the M, P, R, and S failure rate levels. All new designs must utilize the Weibull distribution (dash numbers) and associated failure rate(s). (After August 15, 1984)

Symbol	Exponential Failure Rate Level (%/1,000 hr)	Symbol	Weibull Failure Rate Level (%/1,000 hr)
M	1.0	–	–
P	0.1	B	0.1
R	0.01	C	0.01
S	0.001	D	0.001

The existing exponential lifetest CSR styles required only a 40 hour voltage aging at rated voltage prior to shipment. The failure rate on each lot was determined by the demonstrated generic lifetest data history of any given manufacturer, and that manufacturers' internal testing to guarantee the given failure rate level shipped.

The new CSR Weibull lifetest system, and associated military dash numbers, requires a lot/lot 100% accelerated aging sequence on each lot processed. This aging method utilizes the decreasing rate of failure which is applicable to solid tantalum capacitors, i.e., the rate of failure in any given lot gets smaller and smaller for times in excess of 100,000 hours. The decreasing rate of failure seen during life testing on solid tantalum capacitors makes the Weibull (accelerated voltage) aging concept uniquely correct for these designs.

Statistical treatment becomes somewhat more difficult, but the Weibull approximation fits very nicely and enables a straight line slope when predicting failure rate(s) from observed failure(s) at precise time intervals. This method additionally permits extrapolation to predict the time needed on voltage age to reach a desired failure rate.

In effect, by accelerating the applied voltage during the 85°C aging sequence, we are accelerating the incidence of failure(s) that might occur. These higher than rated voltage applied levels are called acceleration levels (factors) and are carefully designed for each voltage family of devices. As an example, an applied voltage of 1.1 times the rated voltage may indicate that for every hour of test under these conditions is equal to 4X the number of standard 85°C hours, at applied rated voltage. Obviously there are limits of applied voltage permissable under accelerated conditions since the device design could be over stressed.

As can be seen, all new equipment design (August 15, 1984) requires the Weibull dash number series for any CSR style. A thorough grounding in the Weibull theory, as applied to accelerated voltage aging of tantalum capacitors, can be reviewed in the latest revision of MIL-C-39003, capacitors fixed, electrolytic tantalum, general specification for.

MIL-C-39003

QUALIFICATION

LIFE TEST (EXPONENTIAL DASH NUMBERS)

Capacitors shall be tested in accordance with method 108 of MIL-STD-202. The following details and exception shall apply:

(a) Distance of temperature measurements from specimens, in inches — Not applicable.
(b) Method of mounting — Capacitors shall be mounted by their leads.
(c) Test temperature and tolerance — The applicable high test temperature is $125°\,^{+4°}_{-0°}$C. The standard high temperature shall be $85°\,^{+4°}_{-0°}$C.
(d) Operating conditions — rated dc voltage or the derated voltage at 125°C, as applicable, shall be applied gradually (not to exceed 5 minutes either by a slow build-up of the voltage or through a resistor which shall be shorted out within 5 minutes). Voltage shall be applied continuously,except for measurement periods. The impedance of the voltage source, as seen from the terminals of each capacitor, shall not exceed 3 ohms. Storage batteries or an electronic power supply capable of supplying at least 1 ampere when a capacitor is shorted shall be used.
(e) Test condition letter — F (2,000 hours).
(f) Measurements during exposure — DC leakage at the applicable high test temperature shall be made at the following intervals: 0; 250^{+48}_{-0}; $1{,}000^{+48}_{-0}$; $2{,}000^{+72}_{-0}$ hours.

QUALITY CONFORMANCE INSPECTION:

For group C inspection — When tested as specified above, capacitors shall meet the following requirements:

At 25°C:
DC leakage — Shall not exceed the applicable value specified.
Capacitance — Shall change not more than ±2% from the value obtained when measured as specified.
Dissipation factor — Shall not exceed the applicable value specified.

At 85°C:
DC leakage — Shall not exceed the applicable value specified.

At 125°C:
DC leakage — Shall not exceed the applicable value specified.

Capacitors shall be visually examined for evidence of mechanical damage. In addition, capacitors shall be subjected to the insulating sleeving dielectric strength test as specified following these measurements.

Group B Performance check (Exponential Dash Number only)—Capacitor shall be tested as specified above with the following exceptions:

(a) The duration of the test shall be 250 hours.
(b) The 85°C rated voltage shall be used for this test.
(c) The test temperature shall be $85°\,^{+4°}_{-0°}$C.
(d) The insulating sleeving dielectric strength test need not be performed.

Following the Performance check, capacitors shall meet the same requirements as specified for Group C inspection.

Extended life test — Capacitors shall be tested as specified above, except that the duration of the test shall be 10,000 hours. DC leakage (at the applicable high test temperature) shall be made at the following intervals: 0; 250^{+48}_{-0}; $1{,}000^{+48}_{-0}$; $2{,}000^{+72}_{-0}$; and every 2,000 hours thereafter until $10{,}000^{+96}_{-0}$ hours have elapsed.

When tested as specified above, capacitors shall meet the following requirements:

At 25°C:
DC leakage — Shall not exceed 200 percent of the value specified.
Capacitance — Shall change not more than ±10 percent from initial measurement.
Dissipation factor — Shall not exceed the applicable value specified.

At 85°C:
DC leakage — Shall not exceed 200 percent of the value specified.

At 125°C:
DC leakage — Shall not exceed 200 percent of the value specified.

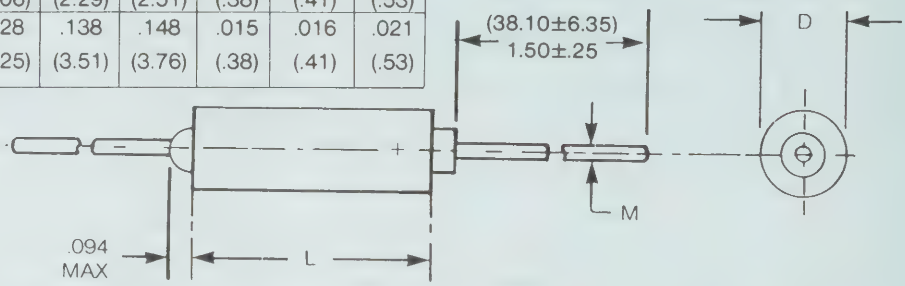
DC Rated and Surge Voltages

Voltage Symbol	DC rated voltage	DC working voltage 85°C	DC working voltage 125°C	DC surge voltage 85°C	DC surge voltage 125°C
B	6	6	4	8	5
C	10	10	7	13	9
D	15	15	10	20	12
E	20	20	13	26	16
F	35	35	23	46	28
G	50	50	33	65	40
H	75	75	50	98	64
J	100	100	67	130	86

MIL-C-39003
Military Style Tantalum Capacitors

MIL-C-39003/02
STYLE CSR09

Dimensions — Inches (mm)									
CASE	L			D			M		
SIZE	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
A1	.235 (5.97)	.250 (6.35)	.281 (7.14)	.081 (2.06)	.090 (2.29)	.099 (2.51)	.015 (.38)	.016 (.41)	.021 (.53)
B1	.375 (9.53)	.390 (9.91)	.405 (10.29)	.128 (3.25)	.138 (3.51)	.148 (3.76)	.015 (.38)	.016 (.41)	.021 (.53)



DC rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage at +25°C	DC leakage at +85°C	DC leakage at +125°C	Dissipation factor at −55°C	Dissipation factor at +25°C	Dissipation factor at +85°C +125°C	Case size	Dash no. M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	µF	Percent	µA	µA	µA	Percent	Percent	Percent		Failure rate level for (%/1,000 hrs)						
6	2.7	5	0.6	6.0	8.0	8	6	6	A1	1001	1061	1121	1181	2001	3001	4001
6	2.7	10	0.6	6.0	8.0	8	6	6	A1	0001	0061	0121	0181	2002	3002	4002
6	18.0	5	1.4	21.6	36.7	8	6	6	B1	1002	1062	1122	1182	2003	3003	4003
6	18.0	10	1.4	21.6	36.7	8	6	6	B1	0002	0062	0122	0182	2004	3004	4004
10	1.8	5	0.6	6.0	8.0	8	6	6	A1	1007	1067	1127	1187	2005	3005	4005
10	1.8	10	0.6	6.0	8.0	8	6	6	A1	0007	0067	0127	0187	2006	3006	4006
10	2.2	5	0.6	6.0	8.0	8	6	6	A1	1008	1068	1128	1188	2007	3007	4007
10	2.2	10	0.6	6.0	8.0	8	6	6	A1	0008	0068	0128	0188	2008	3008	4008
10	10.0	5	2.5	20.0	34.0	8	6	6	B1	1009	1069	1129	1189	2009	3009	4009
10	10.0	10	2.5	20.0	34.0	8	6	6	B1	0009	0069	0129	0189	2010	3010	4010
10	12.0	5	2.5	24.0	40.8	8	6	6	B1	1010	1070	1130	1190	2011	3011	4011
10	12.0	10	2.5	24.0	40.8	8	6	6	B1	0010	0070	0130	0190	2012	3012	4012
10	15.0	5	2.5	30.0	51.0	8	6	6	B1	1011	1071	1131	1191	2013	3013	4013
10	15.0	10	2.5	30.0	51.0	8	6	6	B1	0011	0071	0131	0191	2014	3014	4014
15	1.0	5	0.6	6.0	8.0	8	6	6	A1	1012	1072	1132	1192	2015	3015	4015
15	1.0	10	0.6	6.0	8.0	8	6	6	A1	0012	0072	0132	0192	2016	3016	4016
15	1.2	5	0.6	6.0	8.0	8	6	6	A1	1013	1073	1133	1193	2017	3017	4017
15	1.2	10	0.6	6.0	8.0	8	6	6	A1	0013	0073	0133	0193	2018	3018	4018
15	1.5	5	0.6	6.0	8.0	8	6	6	A1	1014	1074	1134	1194	2019	3019	4019
15	1.5	10	0.6	6.0	8.0	8	6	6	A1	0014	0074	0134	0194	2020	3020	4020
15	8.2	5	1.8	24.6	42.0	8	6	6	B1	1015	1075	1135	1195	2021	3021	4021
15	8.2	10	1.8	24.6	42.0	8	6	6	B1	0015	0075	0135	0195	2022	3022	4022
20	.56	5	0.6	6.0	8.0	4	3	4	A1	1016	1076	1136	1196	2023	3023	4023
20	.56	10	0.6	6.0	8.0	4	3	4	A1	0016	0076	0136	0196	2024	3024	4024
20	.68	5	0.6	6.0	8.0	4	3	4	A1	1017	1077	1137	1197	2025	3025	4025
20	.68	10	0.6	6.0	8.0	4	3	4	A1	0017	0077	0137	0197	2026	3026	4026
20	.82	5	0.6	6.0	8.0	4	3	4	A1	1018	1078	1138	1198	2027	3027	4027
20	.82	10	0.6	6.0	8.0	4	3	4	A1	0018	0078	0138	0198	2028	3028	4028
20	1.0	5	0.6	6.0	8.0	4	3	4	A1	1019	1079	1139	1199	2029	3029	4029
20	1.0	10	0.6	6.0	8.0	4	3	4	A1	0019	0079	0139	0199	2030	3030	4030
20	3.3	5	1.0	13.2	22.4	4	3	4	B1	1020	1080	1140	1200	2031	3031	4031
20	3.3	10	1.0	13.2	22.4	4	3	4	B1	0020	0080	0140	0200	2032	3032	4032
20	3.9	5	2.0	15.6	26.5	4	3	4	B1	1021	1081	1141	1201	2033	3033	4033
20	3.9	10	2.0	15.6	26.5	4	3	4	B1	0021	0081	0141	0201	2034	3034	4034
20	4.7	5	2.0	18.8	32.0	4	3	4	B1	1022	1082	1142	1202	2035	3035	4035
20	4.7	10	2.0	18.8	32.0	4	3	4	B1	0022	0082	0142	0202	2036	3036	4036
20	5.6	5	2.0	22.4	38.1	4	3	4	B1	1023	1083	1143	1203	2037	3037	4037
20	5.6	10	2.0	22.4	38.1	4	3	4	B1	0023	0083	0143	0203	2038	3038	4038
20	6.8	5	2.0	27.2	46.2	4	3	4	B1	1024	1084	1144	1204	2039	3039	4039
20	6.8	10	2.0	27.2	46.2	4	3	4	B1	0024	0084	0144	0204	2040	3040	4040
35	0.33	5	0.6	6.0	8.0	4	3	4	A1	1025	1085	1145	1205	2041	3041	4041
35	0.33	10	0.6	6.0	8.0	4	3	4	A1	0025	0085	0145	0205	2042	3042	4042
35	0.39	5	0.6	6.0	8.0	4	3	4	A1	1026	1086	1146	1206	2043	3043	4043
35	0.39	10	0.6	6.0	8.0	4	3	4	A1	0026	0086	0146	0206	2044	3044	4044
35	0.47	5	0.6	6.0	8.0	4	3	4	A1	1027	1087	1147	1207	2045	3045	4045
35	0.47	10	0.6	6.0	8.0	4	3	4	A1	0027	0087	0147	0207	2046	3046	4046
35	2.2	5	1.4	15.4	26.2	4	3	4	B1	1028	1088	1148	1208	2047	3047	4047
35	2.2	10	1.4	15.4	26.2	4	3	4	B1	0028	0088	0148	0208	2048	3048	4048
35	2.7	5	1.4	18.9	32.1	4	3	4	B1	1029	1089	1149	1209	2049	3049	4049
35	2.7	10	1.4	18.9	32.1	4	3	4	B1	0029	0089	0149	0209	2050	3050	4050

MIL-C-39003/02
STYLE CSR09

DC rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage at +25°C	DC leakage at +85°C	DC leakage at +125°C	Dissipation factor at −55°C	Dissipation factor at +25°C	Dissipation factor at +85°C +125°C	Case size	Dash no. Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	µF	Percent	µA	µA	µA	Percent	Percent	Percent								
50	0.22	5	0.6	6.0	8.0	4	3	4	A1	1030	1090	1150	1210	2051	3051	4051
50	0.22	10	0.6	6.0	8.0	4	3	4	A1	0030	0090	0150	0210	2052	3052	4052
50	0.27	5	0.6	6.0	8.0	4	3	4	A1	1031	1091	1151	1211	2053	3053	4053
50	0.27	10	0.6	6.0	8.0	4	3	4	A1	0031	0091	0151	0211	2054	3054	4054
50	1.5	5	1.4	15.0	25.5	4	3	4	B1	1032	1092	1152	1212	2055	3055	4055
50	1.5	10	1.4	15.0	25.5	4	3	4	B1	0032	0092	0152	0212	2056	3056	4056
50	1.8	5	1.4	18.0	30.6	4	3	4	B1	1033	1093	1153	1213	2057	3057	4057
50	1.8	10	1.4	18.0	30.6	4	3	4	B1	0033	0093	0153	0213	2058	3058	4058
75	0.047	5	0.6	6.0	8.0	4	3	4	A1	1034	1094	1154	1214	2059	3059	4059
75	0.047	10	0.6	6.0	8.0	4	3	4	A1	0034	0094	0154	0214	2060	3060	4060
75	0.056	5	0.6	6.0	8.0	4	3	4	A1	1035	1095	1155	1215	2061	3061	4061
75	0.056	10	0.6	6.0	8.0	4	3	4	A1	0035	0095	0155	0215	2062	3062	4062
75	0.068	5	0.6	6.0	8.0	4	3	4	A1	1036	1096	1156	1216	2063	3063	4063
75	0.068	10	0.6	6.0	8.0	4	3	4	A1	0036	0096	0156	0216	2064	3064	4064
75	0.082	5	0.6	6.0	8.0	4	3	4	A1	1037	1097	1157	1217	2065	3065	4065
75	0.082	10	0.6	6.0	8.0	4	3	4	A1	0037	0097	0157	0217	2066	3066	4066
75	0.10	5	0.6	6.0	8.0	4	3	4	A1	1038	1098	1158	1218	2067	3067	4067
75	0.10	10	0.6	6.0	8.0	4	3	4	A1	0038	0098	0158	0218	2068	3068	4068
75	0.12	5	0.6	6.0	8.0	4	3	4	A1	1039	1099	1159	1219	2069	3069	4069
75	0.12	10	0.6	6.0	8.0	4	3	4	A1	0039	0099	0159	0219	2070	3070	4070
75	0.15	5	0.6	6.0	8.0	4	3	4	A1	1040	1100	1160	1220	2071	3071	4071
75	0.15	10	0.6	6.0	8.0	4	3	4	A1	0040	0100	0160	0220	2072	3072	4072
75	0.18	5	0.6	6.0	8.0	4	3	4	A1	1041	1101	1161	1221	2073	3073	4073
75	0.18	10	0.6	6.0	8.0	4	3	4	A1	0041	0101	0161	0221	2074	3074	4074
75	0.22	5	0.6	6.0	8.0	4	3	4	B1	1042	1102	1162	1222	2075	3075	4075
75	0.22	10	0.6	6.0	8.0	4	3	4	B1	0042	0102	0162	0222	2076	3076	4076
75	0.27	5	0.6	6.0	8.0	4	3	4	B1	1043	1103	1163	1223	2077	3077	4077
75	0.27	10	0.6	6.0	8.0	4	3	4	B1	0043	0103	0163	0223	2078	3078	4078
75	0.33	5	0.6	6.0	8.4	4	3	4	B1	1044	1104	1164	1224	2079	3079	4079
75	0.33	10	0.6	6.0	8.4	4	3	4	B1	0044	0104	0164	0224	2080	3080	4080
75	0.39	5	0.6	6.0	9.9	4	3	4	B1	1045	1105	1165	1225	2081	3081	4081
75	0.39	10	0.6	6.0	9.9	4	3	4	B1	0045	0105	0165	0225	2082	3082	4082
75	0.47	5	0.6	7.0	12.0	4	3	4	B1	1046	1106	1166	1226	2083	3083	4083
75	0.47	10	0.6	7.0	12.0	4	3	4	B1	0046	0106	0166	0226	2084	3084	4084
75	0.56	5	0.6	8.4	14.3	4	3	4	B1	1047	1107	1167	1227	2085	3085	4085
75	0.56	10	0.6	8.4	14.3	4	3	4	B1	0047	0107	0167	0227	2086	3086	4086
75	0.68	5	0.6	10.2	17.3	4	3	4	B1	1048	1108	1168	1228	2087	3087	4087
75	0.68	10	0.6	10.2	17.3	4	3	4	B1	0048	0108	0168	0228	2088	3088	4088
75	0.82	5	0.7	12.3	20.9	4	3	4	B1	1049	1109	1169	1229	2089	3089	4089
75	0.82	10	0.7	12.3	20.9	4	3	4	B1	0049	0109	0169	0229	2090	3090	4090
75	1.0	5	0.9	15.0	25.5	4	3	4	B1	1050	1110	1170	1230	2091	3091	4091
75	1.0	10	0.9	15.0	25.5	4	3	4	B1	0050	0110	0170	0230	2092	3092	4092
75	1.2	5	0.9	18.0	30.6	4	3	4	B1	1051	1111	1171	1231	2093	3093	4093
75	1.2	10	0.9	18.0	30.6	4	3	4	B1	0051	0111	0171	0231	2094	3094	4094

MILITARY CODING SYSTEM

PART NUMBER SYSTEM

EXAMPLE **M39003** **/02** **–0042**

–0042: Dash # assigned for each specific value of capacitance voltage, capacitance tolerance, and failure rate level. See table for specific rating.

/02: Detail sheet for specific style–CSR09

M39003: MIL-C-39003 – Generic specification for established reliability solid tantalum capacitors.

NOTE: *Military number does not specify capacitance voltage, capacitance tolerance, failure rate, or case size. See table.*

MIL-C-39003

Military Style Tantalum Capacitors

MIL-C-39003/01
STYLE CSR13

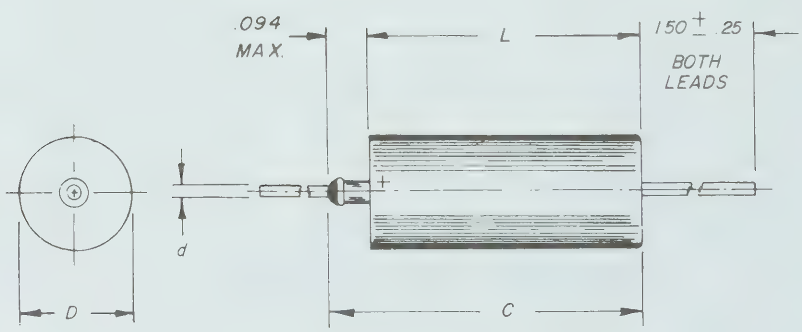
MILITARY CODING SYSTEM

PART NUMBER SYSTEM

EXAMPLE M39003 /01 −2242

- −2242: Dash # assigned for each specific value of capacitance voltage, capacitance tolerance, and failure rate level. See table for specific rating.
- /01: Detail sheet for specific style—CSR13
- M39003: MIL-C-39003 – Generic specification for established reliability solid tantalum capacitors.

NOTE: *Military number does not specify capacitance voltage, capacitance tolerance, failure rate, or case size. See table.*



CASE SIZE	Dimensions – Inches (mm)			
	L ±.031 (.79)	D +.016 (.41) −.015 (.38)	d ±.002 (.05)	C max.
A	0.286 (7.26)	0.135 (3.43)	0.020 (0.51)	0.422 (10.72)
B	0.474 (12.04)	0.185 (4.70)	0.020 (0.51)	0.610 (15.49)
C	0.686 (17.42)	0.289 (7.34)	0.025 (0.64)	0.822 (20.88)
D	0.786 (19.96)	0.351 (8.92)	0.025 (0.64)	0.922 (23.42)

MIL-C-39003/01
STYLE CSR13

DC rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage at +25°C	DC leakage at +85°C	DC leakage at +125°C	Dissipation factor at −55°C +25°C	Dissipation factor at +85°C +125°C	Case size	Dash no. M39003/01- Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	µF	Percent	µA	µA	µA	Percent	Percent								
6	5.6	5	.3	6.0	7.5	4	4	A	5001	5201	5401	5601	6001	7001	8001
6	5.6	10	.3	6.0	7.5	4	4	A	2241	2481	2721	2961	6002	7002	8002
6	6.8	5	.3	6.0	7.5	6	6	A	5002	5202	5402	5602	6003	7003	8003
6	6.8	10	.3	6.0	7.5	6	6	A	2242	2482	2722	2962	6004	7004	8004
6	6.8	20	.3	6.0	7.5	6	6	A	2243	2483	2723	2963	6005	7005	8005
6	47.0	5	1.5	24.0	30.0	6	6	B	5003	5203	5403	5603	6006	7006	8006
6	47.0	10	1.5	24.0	30.0	6	6	B	2244	2484	2724	2964	6007	7007	8007
6	47.0	20	1.5	24.0	30.0	6	6	B	2245	2485	2725	2965	6008	7008	8008
6	56.0	5	1.5	24.0	30.0	6	6	B	5004	5204	5404	5604	6009	7009	8009
6	56.0	10	1.5	24.0	30.0	6	6	B	2246	2486	2726	2966	6010	7010	8010
6	150.0	5	4.5	90.0	113.0	8	8	C	5005	5205	5405	5605	6011	7011	8011
6	150.0	10	4.5	90.0	113.0	8	8	C	2247	2487	2727	2967	6012	7012	8012
6	150.0	20	4.5	90.0	113.0	8	8	C	2248	2488	2728	2968	6013	7013	8013
6	180.0	5	5.5	110.0	138.0	8	8	C	5006	5206	5406	5606	6014	7014	8014
6	180.0	10	5.5	110.0	138.0	8	8	C	2249	2489	2729	2969	6015	7015	8015
6	270.0	5	6.5	130.0	163.0	8	8	D	5007	5207	5407	5607	6016	7016	8016
6	270.0	10	6.5	130.0	163.0	8	8	D	2250	2490	2730	2970	6017	7017	8017
6	330.0	5	7.5	150.0	188.0	8	8	D	5008	5208	5408	5608	6018	7018	8018
6	330.0	10	7.5	150.0	188.0	8	8	D	2251	2491	2731	2971	6019	7019	8019
6	330.0	20	7.5	150.0	188.0	8	8	D	2252	2492	2732	2972	6020	7020	8020
10	3.9	5	.3	6.0	7.5	4	4	A	5009	5209	5409	5609	6021	7021	8021
10	3.9	10	.3	6.0	7.5	4	4	A	2253	2493	2733	2973	6022	7022	8022
10	4.7	5	.4	7.0	8.8	4	4	A	5010	5210	5410	5610	6023	7023	8023
10	4.7	10	.4	7.0	8.8	4	4	A	2254	2494	2734	2974	6024	7024	8024
10	4.7	20	.4	7.0	8.8	4	4	A	2255	2495	2735	2975	6025	7025	8025
10	27.0	5	2.0	40.0	50.0	6	6	B	5011	5211	5411	5611	6026	7026	8026
10	27.0	10	2.0	40.0	50.0	6	6	B	2256	2496	2736	2976	6027	7027	8027
10	33.0	5	2.5	50.0	63.0	6	6	B	5012	5212	5412	5612	6028	7028	8028
10	33.0	10	2.5	50.0	63.0	6	6	B	2257	2497	2737	2977	6029	7029	8029
10	33.0	20	2.5	50.0	63.0	6	6	B	2258	2498	2738	2978	6030	7030	8030
10	39.0	5	2.5	50.0	63.0	6	6	B	5013	5213	5413	5613	6031	7031	8031
10	39.0	10	2.5	50.0	63.0	6	6	B	2259	2499	2739	2979	6032	7032	8032
10	82.0	5	4.0	80.0	100.0	6	6	C	5014	5214	5414	5614	6033	7033	8033
10	82.0	10	4.0	80.0	100.0	6	6	C	2260	2500	2740	2980	6034	7034	8034
10	100.0	5	5.0	100.0	125.0	8	8	C	5015	5215	5415	5615	6035	7035	8035
10	100.0	10	5.0	100.0	125.0	8	8	C	2261	2501	2741	2981	6036	7036	8036
10	100.0	20	5.0	100.0	125.0	8	8	C	2262	2502	2742	2982	6037	7037	8037
10	120.0	5	6.0	120.0	150.0	8	8	C	5016	5216	5416	5616	6038	7038	8038
10	120.0	10	6.0	120.0	150.0	8	8	C	2263	2503	2743	2983	6039	7039	8039
10	180.0	5	9.0	180.0	226.0	8	8	D	5017	5217	5417	5617	6040	7040	8040
10	180.0	10	9.0	180.0	226.0	8	8	D	2264	2504	2744	2984	6041	7041	8041
10	220.0	5	10	200.0	250.0	8	8	D	5018	5218	5418	5618	6042	7042	8042
10	220.0	10	10	200.0	250.0	8	8	D	2265	2505	2745	2985	6043	7043	8043
10	220.0	20	10	200.0	250.0	8	8	D	2266	2506	2746	2986	6044	7044	8044
15	2.7	5	.3	6.0	7.5	4	4	A	5019	5219	5419	5619	6045	7045	8045
15	2.7	10	.3	6.0	7.5	4	4	A	2267	2507	2747	2987	6046	7046	8046
15	3.3	5	.4	8.0	10.0	4	4	A	5020	5220	5420	5620	6047	7047	8047
15	3.3	10	.4	8.0	10.0	4	4	A	2268	2508	2748	2988	6048	7048	8048
15	3.3	20	.4	8.0	10.0	4	4	A	2269	2509	2749	2989	6049	7049	8049
15	18.0	5	2.0	35.0	44.0	6	6	B	5021	5221	5421	5621	6050	7050	8050

MIL-C-39003

Military Style Tantalum Capacitors

MIL-C-39003/01

STYLE CSR13

DC rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage at +25°C	DC leakage at +85°C	DC leakage at +125°C	Dissipation factor at −55°C +25°C	Dissipation factor at +85°C +125°C	Case size	Dash number M39003/01- Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	μF	Percent	μA	μA	μA	Percent	Percent								
15	18.0	10	2.0	35.0	44.0	6	6	B	2270	2510	2750	2990	6051	7051	8051
15	22.0	5	2.0	40.0	50.0	6	6	B	5022	5222	5422	5622	6052	7052	8052
15	22.0	10	2.0	40.0	50.0	6	6	B	2271	2511	2751	2991	6053	7053	8053
15	22.0	20	2.0	40.0	50.0	6	6	B	2272	2512	2752	2992	6054	7054	8054
15	56.0	5	4.0	80.0	100.0	6	6	C	5023	5223	5423	5623	6055	7055	8055
15	56.0	10	4.0	80.0	100.0	6	6	C	2273	2513	2753	2993	6056	7056	8056
15	68.0	5	5.0	100.0	125.0	6	6	C	5024	5224	5424	5624	6057	7057	8057
15	68.0	10	5.0	100.0	125.0	6	6	C	2274	2514	2754	2994	6058	7058	8058
15	68.0	20	5.0	100.0	125.0	6	6	C	2275	2515	2755	2995	6059	7059	8059
15	120.0	5	9.0	180.0	226.0	8	8	D	5025	5225	5425	5625	6060	7060	8060
15	120.0	10	9.0	180.0	226.0	8	8	D	2276	2516	2756	2996	6061	7061	8061
15	150.0	5	10.0	200.0	250.0	8	8	D	5026	5226	5426	5626	6062	7062	8062
15	150.0	10	10.0	200.0	250.0	8	8	D	2277	2517	2757	2997	6063	7063	8063
15	150.0	20	10.0	200.0	250.0	8	8	D	2278	2518	2758	2998	6064	7064	8064
20	1.2	5	.3	6.0	7.5	4	4	A	5027	5227	5427	5627	6065	7065	8065
20	1.2	10	.3	6.0	7.5	4	4	A	2279	2519	2759	2999	6066	7066	8066
20	1.5	5	.3	6.0	7.5	4	4	A	5028	5228	5428	5628	6067	7067	8067
20	1.5	10	.3	6.0	7.5	4	4	A	2280	2520	2760	3000	6068	7068	8068
20	1.5	20	.3	6.0	7.5	4	4	A	2281	2521	2761	3001	6069	7069	8069
20	1.8	5	.3	6.0	7.5	4	4	A	5029	5229	5429	5629	6070	7070	8070
20	1.8	10	.3	6.0	7.5	4	4	A	2282	2522	2762	3002	6071	7071	8071
20	2.2	5	.4	8.0	10.0	4	4	A	5030	5230	5430	5630	6072	7072	8072
20	2.2	10	.4	8.0	10.0	4	4	A	2283	2523	2763	3003	6073	7073	8073
20	2.2	20	.4	8.0	10.0	4	4	A	2284	2524	2764	3004	6074	7074	8074
20	8.2	5	1.0	20.0	25.0	6	6	B	5031	5231	5431	5631	6075	7075	8075
20	8.2	10	1.0	20.0	25.0	6	6	B	2285	2525	2765	3005	6076	7076	8076
20	10.0	5	1.5	30.0	38.0	6	6	B	5032	5232	5432	5632	6077	7077	8077
20	10.0	10	1.5	30.0	38.0	6	6	B	2286	2526	2766	3006	6078	7078	8078
20	10.0	20	1.5	30.0	38.0	6	6	B	2287	2527	2767	3007	6079	7079	8079
20	12.0	5	1.8	35.0	44.0	6	6	B	5033	5233	5433	5633	6080	7080	8080
20	12.0	10	1.8	35.0	44.0	6	6	B	2288	2528	2768	3008	6081	7081	8081
20	15.0	5	2.0	40.0	50.0	6	6	B	5034	5234	5434	5634	6082	7082	8082
20	15.0	10	2.0	40.0	50.0	6	6	B	2289	2529	2769	3009	6083	7083	8083
20	15.0	20	2.0	40.0	50.0	6	6	B	2290	2530	2770	3010	6084	7084	8084
20	27.0	5	2.5	50.0	63.0	6	6	C	5035	5235	5435	5635	6085	7085	8085
20	27.0	10	2.5	50.0	63.0	6	6	C	2291	2531	2771	3011	6086	7086	8086
20	33.0	5	3.5	70.0	88.0	6	6	C	5036	5236	5436	5636	6087	7087	8087
20	33.0	10	3.5	70.0	88.0	6	6	C	2292	2532	2772	3012	6088	7088	8088
20	33.0	20	3.5	70.0	88.0	6	6	C	2293	2533	2773	3013	6089	7089	8089
20	39.0	5	4.0	80.0	100.0	6	6	C	5037	5237	5437	5637	6090	7090	8090
20	39.0	10	4.0	80.0	100.0	6	6	C	2294	2534	2774	3014	6091	7091	8091
20	47.0	5	4.5	90.0	113.0	6	6	C	5038	5238	5438	5638	6092	7092	8092
20	47.0	10	4.5	90.0	113.0	6	6	C	2295	2535	2775	3015	6093	7093	8093
20	47.0	20	4.5	90.0	113.0	6	6	C	2296	2536	2776	3016	6094	7094	8094
20	56.0	5	5.5	110.0	138.0	6	6	D	5039	5239	5439	5639	6095	7095	8095
20	56.0	10	5.5	110.0	138.0	6	6	D	2297	2537	2777	3017	6096	7096	8096
20	68.0	5	7.0	140.0	175.0	6	6	D	5040	5240	5440	5640	6097	7097	8097
20	68.0	10	7.0	140.0	175.0	6	6	D	2298	2538	2778	3018	6098	7098	8098
20	68.0	20	7.0	140.0	175.0	6	6	D	2299	2539	2779	3019	6099	7099	8099
20	82.0	5	8.0	160.0	200.0	6	6	D	5041	5241	5441	5641	6100	7100	8100

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DC rated voltage	Capaci-tance (nom)	Capacitance tolerance	DC leakage at			Dissipation factor at		Case size	Dash no. M39003/01-						
									Failure rate level for (%/1,000 hrs)						
			+25°C	+85°C	+125°C	−55°C +25°C	+85°C +125°C		M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	µF	Percent	µA	µA	µA	Percent	Percent								
20	82.0	10	8.0	160.0	200.0	6	6	D	2300	2540	2780	3020	6101	7101	8101
20	100.0	5	10.0	200.0	250.0	8	8	D	5042	5242	5442	5642	6102	7102	8102
20	100.0	10	10.0	200.0	250.0	8	8	D	2301	2541	2781	3021	6103	7103	8103
20	100.0	20	10.0	200.0	250.0	8	8	D	2302	2542	2782	3022	6104	7104	8104
35	5.6	5	1.3	25.0	32.0	4	4	B	5043	5243	5443	5643	6105	7105	8105
35	5.6	10	1.3	25.0	32.0	4	4	B	2303	2543	2783	3023	6106	7106	8106
35	6.8	5	1.5	30.0	38.0	6	6	B	5044	5244	5444	5644	6107	7107	8107
35	6.8	10	1.5	30.0	38.0	6	6	B	2304	2544	2784	3024	6108	7108	8108
35	6.8	20	1.5	30.0	38.0	6	6	B	2305	2545	2785	3025	6109	7109	8109
35	22.0	5	4.0	80.0	100.0	6	6	C	5045	5245	5445	5645	6110	7110	8110
35	22.0	10	4.0	80.0	100.0	6	6	C	2306	2546	2786	3026	6111	7111	8111
35	22.0	20	4.0	80.0	100.0	6	6	C	2307	2547	2787	3027	6112	7112	8112
35	27.0	5	4.5	90.0	113.0	6	6	D	5046	5246	5446	5646	6113	7113	8113
35	27.0	10	4.5	90.0	113.0	6	6	D	2308	2548	2788	3028	6114	7114	8114
35	33.0	5	5.5	110.0	138.0	6	6	D	5047	5247	5447	5647	6115	7115	8115
35	33.0	10	5.5	110.0	138.0	6	6	D	2309	2549	2789	3029	6116	7116	8116
35	33.0	20	5.5	110.0	138.0	6	6	D	2310	2550	2790	3030	6117	7117	8117
35	39.0	5	7.0	140.0	175.0	6	6	D	5048	5248	5448	5648	6118	7118	8118
35	39.0	10	7.0	140.0	175.0	6	6	D	2311	2551	2791	3031	6119	7119	8119
35	47.0	5	8.0	160.0	200.0	6	6	D	5049	5249	5449	5649	6120	7120	8120
35	47.0	10	8.0	160.0	200.0	6	6	D	2312	2552	2792	3032	6121	7121	8121
35	47.0	20	8.0	160.0	200.0	6	6	D	2313	2553	2793	3033	6122	7122	8122
50	.0047	5	.3	5.0	6.3	2	4	A	5050	5250	5450	5650	6123	7123	8123
50	.0047	10	.3	5.0	6.3	2	4	A	2314	2554	2794	3034	6124	7124	8124
50	.0047	20	.3	5.0	6.3	2	4	A	2315	2555	2795	3035	6125	7125	8125
50	.0056	5	.3	5.0	6.3	2	4	A	5051	5251	5451	5651	6126	7126	8126
50	.0056	10	.3	5.0	6.3	2	4	A	2316	2556	2796	3036	6127	7127	8127
50	.0068	5	.3	5.0	6.3	2	4	A	5052	5252	5452	5652	6128	7128	8128
50	.0068	10	.3	5.0	6.3	2	4	A	2317	2557	2797	3037	6129	7129	8129
50	.0068	20	.3	5.0	6.3	2	4	A	2318	2558	2798	3038	6130	7130	8130
50	.0082	5	.3	5.0	6.3	2	4	A	5053	5253	5453	5653	6131	7131	8131
50	.0082	10	.3	5.0	6.3	2	4	A	2319	2559	2799	3039	6132	7132	8132
50	.01	5	.3	5.0	6.3	2	4	A	5054	5254	5454	5654	6133	7133	8133
50	.01	10	.3	5.0	6.3	2	4	A	2320	2560	2800	3040	6134	7134	8134
50	.01	20	.3	5.0	6.3	2	4	A	2321	2561	2801	3041	6135	7135	8135
50	.012	5	.3	5.0	6.3	2	4	A	5055	5255	5455	5655	6136	7136	8136
50	.012	10	.3	5.0	6.3	2	4	A	2322	2562	2802	3042	6137	7137	8137
50	.015	5	.3	5.0	6.3	2	4	A	5056	5256	5456	5656	6138	7138	8138
50	.015	10	.3	5.0	6.3	2	4	A	2323	2563	2803	3043	6139	7139	8139
50	.015	20	.3	5.0	6.3	2	4	A	2324	2564	2804	3044	6140	7140	8140
50	.018	5	.3	5.0	6.3	2	4	A	5057	5257	5457	5657	6141	7141	8141
50	.018	10	.3	5.0	6.3	2	4	A	2325	2565	2805	3045	6142	7142	8142
50	.022	5	.3	5.0	6.3	2	4	A	5058	5258	5458	5658	6143	7143	8143
50	.022	10	.3	5.0	6.3	2	4	A	2326	2566	2806	3046	6144	7144	8144
50	.022	20	.3	5.0	6.3	2	4	A	2327	2567	2807	3047	6145	7145	8145
50	.027	5	.3	5.0	6.3	2	4	A	5059	5259	5459	5659	6146	7146	8146
50	.027	10	.3	5.0	6.3	2	4	A	2328	2568	2808	3048	6147	7147	8147
50	.033	5	.3	5.0	6.3	2	4	A	5060	5260	5460	5660	6148	7148	8148
50	.033	10	.3	5.0	6.3	2	4	A	2329	2569	2809	3049	6149	7149	8149
50	.033	20	.3	5.0	6.3	2	4	A	2330	2570	2810	3050	6150	7150	8150

MIL-C-39003

Military Style Tantalum Capacitors

MIL-C-39003/01
STYLE CSR13

DC rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage at +25°C	DC leakage at +85°C	DC leakage at +125°C	Dissipation factor at −55°C +25°C	Dissipation factor at +85°C +125°C	Case size	Dash no. M39003/01- Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	µF	Percent	µA	µA	µA	Percent	Percent								
50	.039	5	.3	5.0	6.3	2	4	A	5061	5261	5461	5661	6151	7151	8151
50	.039	10	.3	5.0	6.3	2	4	A	2331	2571	2811	3051	6152	7152	8152
50	.047	5	.3	5.0	6.3	2	4	A	5062	5262	5462	5662	6153	7153	8153
50	.047	10	.3	5.0	6.3	2	4	A	2332	2572	2812	3052	6154	7154	8154
50	.047	20	.3	5.0	6.3	2	4	A	2333	2573	2813	3053	6155	7155	8155
50	.056	5	.3	5.0	6.3	2	4	A	5063	5263	5463	5663	6156	7156	8156
50	.056	10	.3	5.0	6.3	2	4	A	2334	2574	2814	3054	6157	7157	8157
50	.068	5	.3	5.0	6.3	2	4	A	5064	5264	5464	5664	6158	7158	8158
50	.068	10	.3	5.0	6.3	2	4	A	2335	2575	2815	3055	6159	7159	8159
50	.068	20	.3	5.0	6.3	2	4	A	2336	2576	2816	3056	6160	7160	8160
50	.082	5	.3	5.0	6.3	2	4	A	5065	5265	5465	5665	6161	7161	8161
50	.082	10	.3	5.0	6.3	2	4	A	2337	2577	2817	3057	6162	7162	8162
50	.1	5	.3	5.0	6.3	2	4	A	5066	5266	5466	5666	6163	7163	8163
50	.1	10	.3	5.0	6.3	2	4	A	2338	2578	2818	3058	6164	7164	8164
50	.1	20	.3	5.0	6.3	2	4	A	2339	2579	2819	3059	6165	7165	8165
50	.12	5	.3	5.0	6.3	2	4	A	5067	5267	5467	5667	6166	7166	8166
50	.12	10	.3	5.0	6.3	2	4	A	2340	2580	2820	3060	6167	7167	8167
50	.15	5	.3	5.0	6.3	2	4	A	5068	5268	5468	5668	6168	7168	8168
50	.15	10	.3	5.0	6.3	2	4	A	2341	2581	2821	3061	6169	7169	8169
50	.15	20	.3	5.0	6.3	2	4	A	2342	2582	2822	3062	6170	7170	8170
50	.18	5	.3	5.0	6.3	2	4	A	5069	5269	5469	5669	6171	7171	8171
50	.18	10	.3	5.0	6.3	2	4	A	2343	2583	2823	3063	6172	7172	8172
50	.22	5	.3	5.0	6.3	2	4	A	5070	5270	5470	5670	6173	7173	8173
50	.22	10	.3	5.0	6.3	2	4	A	2344	2584	2824	3064	6174	7174	8174
50	.22	20	.3	5.0	6.3	2	4	A	2345	2585	2825	3065	6175	7175	8175
50	.27	5	.3	5.0	6.3	2	4	A	5071	5271	5471	5671	6176	7176	8176
50	.27	10	.3	5.0	6.3	2	4	A	2346	2586	2826	3066	6177	7177	8177
50	.33	5	.3	5.0	6.3	2	4	A	5072	5272	5472	5672	6178	7178	8178
50	.33	10	.3	5.0	6.3	2	4	A	2347	2587	2827	3067	6179	7179	8179
50	.33	20	.3	5.0	6.3	2	4	A	2348	2588	2828	3068	6180	7180	8180
50	.39	5	.3	5.0	6.3	2	4	A	5073	5273	5473	5673	6181	7181	8181
50	.39	10	.3	5.0	6.3	2	4	A	2349	2589	2829	3069	6182	7182	8182
50	.47	5	.3	5.0	6.3	2	4	A	5074	5274	5474	5674	6183	7183	8183
50	.47	10	.3	5.0	6.3	2	4	A	2350	2590	2830	3070	6184	7184	8184
50	.47	20	.3	5.0	6.3	2	4	A	2351	2591	2831	3071	6185	7185	8185
50	.56	5	.3	5.0	6.3	2	4	A	5075	5275	5475	5675	6186	7186	8186
50	.56	10	.3	5.0	6.3	2	4	A	2352	2592	2832	3072	6187	7187	8187
50	.68	5	.3	5.0	6.3	2	4	A	5076	5276	5476	5676	6188	7188	8188
50	.68	10	.3	5.0	6.3	2	4	A	2353	2593	2833	3073	6189	7189	8189
50	.68	20	.3	5.0	6.3	2	4	A	2354	2594	2834	3074	6190	7190	8190
50	.82	5	.3	5.0	6.3	2	4	A	5077	5277	5477	5677	6191	7191	8191
50	.82	10	.3	5.0	6.3	2	4	A	2355	2595	2835	3075	6192	7192	8192
50	1.0	5	.4	8.0	10.0	2	4	A	5078	5278	5478	5678	6193	7193	8193
50	1.0	10	.4	8.0	10.0	2	4	A	2356	2596	2836	3076	6194	7194	8194
50	1.0	20	.4	8.0	10.0	2	4	A	2357	2597	2837	3077	6195	7195	8195
50	1.2	5	.4	9.0	11.0	4	4	B	5079	5279	5479	5679	6196	7196	8196
50	1.2	10	.4	9.0	11.0	4	4	B	2358	2598	2838	3078	6197	7197	8197
50	1.5	5	.6	12.0	15.0	4	4	B	5080	5280	5480	5680	6198	7198	8198
50	1.5	10	.6	12.0	15.0	4	4	B	2359	2599	2839	3079	6199	7199	8199
50	1.5	20	.6	12.0	15.0	4	4	B	2360	2600	2840	3080	6200	7200	8200

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DC rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage at			Dissipation factor at		Case size	Dash number M39003/01- Failure rate level for (%/1,000 hrs)						
			+25°C	+85°C	+125°C	−55°C +25°C	+85°C +125°C		M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	µF	Percent	µA	µA	µA	Percent	Percent								
50	1.8	5	.7	14.0	18.0	4	4	B	5081	5281	5481	5681	6201	7201	8201
50	1.8	10	.7	14.0	18.0	4	4	B	2361	2601	2841	3081	6202	7202	8202
50	2.2	5	.8	17.0	22.0	4	4	B	5082	5282	5482	5682	6203	7203	8203
50	2.2	10	.8	17.0	22.0	4	4	B	2362	2602	2842	3082	6204	7204	8204
50	2.2	20	.8	17.0	22.0	4	4	B	2363	2603	2843	3083	6205	7205	8205
50	2.7	5	1.0	20.0	25.0	4	4	B	5083	5283	5483	5683	6206	7206	8206
50	2.7	10	1.0	20.0	25.0	4	4	B	2364	2604	2844	3084	6207	7207	8207
50	3.3	5	1.2	25.0	32.0	4	4	B	5084	5284	5484	5684	6208	7208	8208
50	3.3	10	1.2	25.0	32.0	4	4	B	2365	2605	2845	3085	6209	7209	8209
50	3.3	20	1.2	25.0	32.0	4	4	B	2366	2606	2846	3086	6210	7210	8210
50	3.9	5	1.5	30.0	38.0	4	4	B	5085	5285	5485	5685	6211	7211	8211
50	3.9	10	1.5	30.0	38.0	4	4	B	2367	2607	2847	3087	6212	7212	8212
50	4.7	5	1.7	35.0	44.0	4	4	B	5086	5286	5486	5686	6213	7213	8213
50	4.7	10	1.7	35.0	44.0	4	4	B	2368	2608	2848	3088	6214	7214	8214
50	4.7	20	1.7	35.0	44.0	4	4	B	2369	2609	2849	3089	6215	7215	8215
50	5.6	5	2.2	45.0	56.0	4	4	C	5087	5287	5487	5687	6216	7216	8216
50	5.6	10	2.2	45.0	56.0	4	4	C	2370	2610	2850	3090	6217	7217	8217
50	6.8	5	2.2	45.0	56.0	6	6	C	5088	5288	5488	5688	6218	7218	8218
50	6.8	10	2.2	45.0	56.0	6	6	C	2371	2611	2851	3091	6219	7219	8219
50	6.8	20	2.2	45.0	56.0	6	6	C	2372	2612	2852	3092	6220	7220	8220
50	8.2	5	2.5	50.0	63.0	6	6	C	5089	5289	5489	5689	6221	7221	8221
50	8.2	10	2.5	50.0	63.0	6	6	C	2373	2613	2853	3093	6222	7222	8222
50	10.0	5	2.5	50.0	63.0	6	6	C	5090	5290	5490	5690	6223	7223	8223
50	10.0	10	2.5	50.0	63.0	6	6	C	2374	2614	2854	3094	6224	7224	8224
50	10.0	20	2.5	50.0	63.0	6	6	C	2375	2615	2855	3095	6225	7225	8225
50	12.0	5	3.0	60.0	75.0	6	6	C	5091	5291	5491	5691	6226	7226	8226
50	12.0	10	3.0	60.0	75.0	6	6	C	2376	2616	2856	3096	6227	7227	8227
50	15.0	5	4.0	80.0	100.0	6	6	C	5092	5292	5492	5692	6228	7228	8228
50	15.0	10	4.0	80.0	100.0	6	6	C	2377	2617	2857	3097	6229	7229	8229
50	15.0	20	4.0	80.0	100.0	6	6	C	2378	2618	2858	3098	6230	7230	8230
50	18.0	5	4.5	90.0	113.0	6	6	C	5093	5293	5493	5693	6231	7231	8231
50	18.0	10	4.5	90.0	113.0	6	6	C	2379	2619	2859	3099	6232	7232	8232
50	22.0	5	5.5	110.0	138.0	6	6	D	5094	5294	5494	5694	6233	7233	8233
50	22.0	10	5.5	110.0	138.0	6	6	D	2380	2620	2860	3100	6234	7234	8234
50	22.0	20	5.5	110.0	138.0	6	6	D	2381	2621	2861	3101	6235	7235	8235
75	.1	5	.3	5.0	6.3	2	4	A	5095	5295	5495	5695	6236	7236	8236
75	.1	10	.3	5.0	6.3	2	4	A	2382	2622	2862	3102	6237	7237	8237
75	.1	20	.3	5.0	6.3	2	4	A	2383	2623	2863	3103	6238	7238	8238
75	.12	5	.3	5.0	6.3	2	4	A	5096	5296	5496	5696	6239	7239	8239
75	.12	10	.3	5.0	6.3	2	4	A	2384	2624	2864	3104	6240	7240	8240
75	.15	5	.3	5.0	6.3	2	4	A	5097	5297	5497	5697	6241	7241	8241
75	.15	10	.3	5.0	6.3	2	4	A	2385	2625	2865	3105	6242	7242	8242
75	.15	20	.3	5.0	6.3	2	4	A	2386	2626	2866	3106	6243	7243	8243
75	.18	5	.3	5.0	6.3	2	4	A	5098	5298	5498	5698	6244	7244	8244
75	.18	10	.3	5.0	6.3	2	4	A	2387	2627	2867	3107	6245	7245	8245
75	.22	5	.3	5.0	6.3	2	4	A	5099	5299	5499	5699	6246	7246	8246
75	.22	10	.3	5.0	6.3	2	4	A	2388	2628	2868	3108	6247	7247	8247
75	.22	20	.3	5.0	6.3	2	4	A	2389	2629	2869	3109	6248	7248	8248
75	.27	5	.3	5.0	6.3	2	4	A	5100	5300	5500	5700	6249	7249	8249
75	.27	10	.3	5.0	6.3	2	4	A	2390	2630	2870	3110	6250	7250	8250

MIL-C-39003

Military Style Tantalum Capacitors

MIL-C-39003/01
STYLE CSR13

DC rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage at			Dissipation factor at		Case size	Dash no. M39003/01- Failure rate level for (%/1,000 hrs)						
			+25°C	+85°C	+125°C	−55°C +25°C	+85°C +125°C		M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	μF	Percent	μA	μA	μA	Percent	Percent								
75	.33	5	.3	5.0	6.3	2	4	A	5101	5301	5501	5701	6251	7251	8251
75	.33	10	.3	5.0	6.3	2	4	A	2391	2631	2871	3111	6252	7252	8252
75	.33	20	.3	5.0	6.3	2	4	A	2392	2632	2872	3112	6253	7253	8253
75	.39	5	.3	5.0	6.3	2	4	A	5102	5302	5502	5702	6254	7254	8254
75	.39	10	.3	5.0	6.3	2	4	A	2393	2633	2873	3113	6255	7255	8255
75	.47	5	.3	5.0	6.3	2	4	A	5103	5303	5503	5703	6256	7256	8256
75	.47	10	.3	5.0	6.3	2	4	A	2394	2634	2874	3114	6257	7257	8257
75	.47	20	.3	5.0	6.3	2	4	A	2395	2635	2875	3115	6258	7258	8258
75	.56	5	.3	5.0	6.3	2	4	A	5104	5304	5504	5704	6259	7259	8259
75	.56	10	.3	5.0	6.3	2	4	A	2396	2636	2876	3116	6260	7260	8260
75	.68	5	.3	5.0	6.3	2	4	A	5105	5305	5505	5705	6261	7261	8261
75	.68	10	.3	5.0	6.3	2	4	A	2397	2637	2877	3117	6262	7262	8262
75	.68	20	.3	5.0	6.3	2	4	A	2398	2638	2878	3118	6263	7263	8263
75	.82	5	.3	5.0	6.3	2	4	B	5106	5306	5506	5706	6264	7264	8264
75	.82	10	.3	5.0	6.3	2	4	B	2399	2639	2879	3119	6265	7265	8265
75	1.0	5	.3	5.0	6.3	2	4	B	5107	5307	5507	5707	6266	7266	8266
75	1.0	10	.3	5.0	6.3	2	4	B	2400	2640	2880	3120	6267	7267	8267
75	1.0	20	.3	5.0	6.3	2	4	B	2401	2641	2881	3121	6268	7268	8268
75	1.2	5	.3	5.0	6.3	4	4	B	5108	5308	5508	5708	6269	7269	8269
75	1.2	10	.3	5.0	6.3	4	4	B	2402	2642	2882	3122	6270	7270	8270
75	1.5	5	.6	10.0	13.0	4	4	B	5109	5309	5509	5709	6271	7271	8271
75	1.5	10	.6	10.0	13.0	4	4	B	2403	2643	2883	3123	6272	7272	8272
75	1.5	20	.6	10.0	13.0	4	4	B	2404	2644	2884	3124	6273	7273	8273
75	1.8	5	.7	10.0	13.0	4	4	B	5110	5310	5510	5710	6274	7274	8274
75	1.8	10	.7	10.0	13.0	4	4	B	2405	2645	2885	3125	6275	7275	8275
75	2.2	5	.8	15.0	19.0	4	4	B	5111	5311	5511	5711	6276	7276	8276
75	2.2	10	.8	15.0	19.0	4	4	B	2406	2646	2886	3126	6277	7277	8277
75	2.2	20	.8	15.0	19.0	4	4	B	2407	2647	2887	3127	6278	7278	8278
75	2.7	5	1.0	15.0	19.0	4	4	B	5112	5312	5512	5712	6279	7279	8279
75	2.7	10	1.0	15.0	19.0	4	4	B	2408	2648	2888	3128	6280	7280	8280
75	3.3	5	1.2	20.0	25.0	4	4	B	5113	5313	5513	5713	6281	7281	8281
75	3.3	10	1.2	20.0	25.0	4	4	B	2409	2649	2889	3129	6282	7282	8282
75	3.3	20	1.2	20.0	25.0	4	4	B	2410	2650	2890	3130	6283	7283	8283
75	3.9	5	1.5	20.0	25.0	4	4	B	5114	5314	5514	5714	6284	7284	8284
75	3.9	10	1.5	20.0	25.0	4	4	B	2411	2651	2891	3131	6285	7285	8285
75	4.7	5	3.0	60.0	75.0	4	4	C	5115	5315	5515	5715	6286	7286	8286
75	4.7	10	3.0	60.0	75.0	4	4	C	2412	2652	2892	3132	6287	7287	8287
75	4.7	20	3.0	60.0	75.0	4	4	C	2413	2653	2893	3133	6288	7288	8288
75	5.6	5	3.0	60.0	75.0	4	4	C	5116	5316	5516	5716	6289	7289	8289
75	5.6	10	3.0	60.0	75.0	4	4	C	2414	2654	2894	3134	6290	7290	8290
75	6.8	5	5.0	100.0	125.0	6	6	C	5117	5317	5517	5717	6291	7291	8291
75	6.8	10	5.0	100.0	125.0	6	6	C	2415	2655	2895	3135	6292	7292	8292
75	6.8	20	5.0	100.0	125.0	6	6	C	2416	2656	2896	3136	6293	7293	8293
75	8.2	5	5.0	100.0	125.0	6	6	C	5118	5318	5518	5718	6294	7294	8294
75	8.2	10	5.0	100.0	125.0	6	6	C	2417	2657	2897	3137	6295	7295	8295
75	10.0	5	5.0	100.0	125.0	6	6	C	5119	5319	5519	5719	6296	7296	8296
75	10.0	10	5.0	100.0	125.0	6	6	C	2418	2658	2898	3138	6297	7297	8297
75	10.0	20	5.0	100.0	125.0	6	6	C	2419	2659	2899	3139	6298	7298	8298
75	12.0	5	5.0	100.0	125.0	6	6	D	5120	5320	5520	5720	6299	7299	8299
75	12.0	10	5.0	100.0	125.0	6	6	D	2420	2660	2900	3140	6300	7300	8300

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DC rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage at +25°C	DC leakage at +85°C	DC leakage at +125°C	Dissipation factor at −55°C +25°C	Dissipation factor at +85°C +125°C	Case size	Dash no. M39003/01- Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	μF	Percent	μA	μA	μA	Percent	Percent								
75	15.0	5	7.0	140.0	175.0	6	6	D	5121	5321	5521	5721	6301	7301	8301
75	15.0	10	7.0	140.0	175.0	6	6	D	2421	2661	2901	3141	6302	7302	8302
75	15.0	20	7.0	140.0	175.0	6	6	D	2422	2662	2902	3142	6303	7303	8303
100	.0047	5	.3	5.0	6.3	2	4	A	5122	5322	5522	5722	6304	7304	8304
100	.0047	10	.3	5.0	6.3	2	4	A	2423	2663	2903	3143	6305	7305	8305
100	.0047	20	.3	5.0	6.3	2	4	A	2424	2664	2904	3144	6306	7306	8306
100	.0056	5	.3	5.0	6.3	2	4	A	5123	5323	5523	5723	6307	7307	8307
100	.0056	10	.3	5.0	6.3	2	4	A	2425	2665	2905	3145	6308	7308	8308
100	.0068	5	.3	5.0	6.3	2	4	A	5124	5324	5524	5724	6309	7309	8309
100	.0068	10	.3	5.0	6.3	2	4	A	2426	2666	2906	3146	6310	7310	8310
100	.0068	20	.3	5.0	6.3	2	4	A	2427	2667	2907	3147	6311	7311	8311
100	.0082	5	.3	5.0	6.3	2	4	A	5125	5325	5525	5725	6312	7312	8312
100	.0082	10	.3	5.0	6.3	2	4	A	2428	2668	2908	3148	6313	7313	8313
100	.01	5	.3	5.0	6.3	2	4	A	5126	5326	5526	5726	6314	7314	8314
100	.01	10	.3	5.0	6.3	2	4	A	2429	2669	2909	3149	6315	7315	8315
100	.01	20	.3	5.0	6.3	2	4	A	2430	2670	2910	3150	6316	7316	8316
100	.012	5	.3	5.0	6.3	2	4	A	5127	5327	5527	5727	6317	7317	8317
100	.012	10	.3	5.0	6.3	2	4	A	2431	2671	2911	3151	6318	7318	8318
100	.015	5	.3	5.0	6.3	2	4	A	5128	5328	5528	5728	6319	7319	8319
100	.015	10	.3	5.0	6.3	2	4	A	2432	2672	2912	3152	6320	7320	8320
100	.015	20	.3	5.0	6.3	2	4	A	2433	2673	2913	3153	6321	7321	8321
100	.018	5	.3	5.0	6.3	2	4	A	5129	5329	5529	5729	6322	7322	8322
100	.018	10	.3	5.0	6.3	2	4	A	2434	2674	2914	3154	6323	7323	8323
100	.022	5	.3	5.0	6.3	2	4	A	5130	5330	5530	5730	6324	7324	8324
100	.022	10	.3	5.0	6.3	2	4	A	2435	2675	2915	3155	6325	7325	8325
100	.022	20	.3	5.0	6.3	2	4	A	2436	2676	2916	3156	6326	7326	8326
100	.027	5	.3	5.0	6.3	2	4	A	5131	5331	5531	5731	6327	7327	8327
100	.027	10	.3	5.0	6.3	2	4	A	2437	2677	2917	3157	6328	7328	8328
100	.033	5	.3	5.0	6.3	2	4	A	5132	5332	5532	5732	6329	7329	8329
100	.033	10	.3	5.0	6.3	2	4	A	2438	2678	2918	3158	6330	7330	8330
100	.033	20	.3	5.0	6.3	2	4	A	2439	2679	2919	3159	6331	7331	8331
100	.039	5	.3	5.0	6.3	2	4	A	5133	5333	5533	5733	6332	7332	8332
100	.039	10	.3	5.0	6.3	2	4	A	2440	2680	2920	3160	6333	7333	8333
100	.047	5	.3	5.0	6.3	2	4	A	5134	5334	5534	5734	6334	7334	8334
100	.047	10	.3	5.0	6.3	2	4	A	2441	2681	2921	3161	6335	7335	8335
100	.047	20	.3	5.0	6.3	2	4	A	2442	2682	2922	3162	6336	7336	8336
100	.056	5	.3	5.0	6.3	2	4	A	5135	5335	5535	5735	6337	7337	8337
100	.056	10	.3	5.0	6.3	2	4	A	2443	2683	2923	3163	6338	7338	8338
100	.068	5	.3	5.0	6.3	2	4	A	5136	5336	5536	5736	6339	7339	8339
100	.068	10	.3	5.0	6.3	2	4	A	2444	2684	2924	3164	6340	7340	8340
100	.068	20	.3	5.0	6.3	2	4	A	2445	2685	2925	3165	6341	7341	8341
100	.082	5	.3	5.0	6.3	2	4	A	5137	5337	5537	5737	6342	7342	8342
100	.082	10	.3	5.0	6.3	2	4	A	2446	2686	2926	3166	6343	7343	8343
100	.1	5	.3	5.0	6.3	2	4	A	5138	5338	5538	5738	6344	7344	8344
100	.1	10	.3	5.0	6.3	2	4	A	2447	2687	2927	3167	6345	7345	8345
100	.1	20	.3	5.0	6.3	2	4	A	2448	2688	2928	3168	6346	7346	8346
100	.12	5	.3	5.0	6.3	2	4	A	5139	5339	5539	5739	6347	7347	8347
100	.12	10	.3	5.0	6.3	2	4	A	2449	2689	2929	3169	6348	7348	8348
100	.15	5	.3	5.0	6.3	2	4	A	5140	5340	5540	5740	6349	7349	8349
100	.15	10	.3	5.0	6.3	2	4	A	2450	2690	2930	3170	6350	7350	8350

MIL-C-39003

Military Style Tantalum Capacitors

MIL-C-39003/01
STYLE CSR13

DC rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage at			Dissipation factor at		Case size	Dash number M39003/01-						
									Failure rate level for (%/1,000 hrs)						
			+25°C	+85°C	+125°C	−55°C +25°C	+85°C +125°C		M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	µF	Percent	µA	µA	µA	Percent	Percent								
100	.15	20	.3	5.0	6.3	2	4	A	2451	2691	2931	3171	6351	7351	8351
100	.18	5	.3	5.0	6.3	2	4	A	5141	5341	5541	5741	6352	7352	8352
100	.18	10	.3	5.0	6.3	2	4	A	2452	2692	2932	3172	6353	7353	8353
100	.22	5	.3	5.0	6.3	2	4	A	5142	5342	5542	5742	6354	7354	8354
100	.22	10	.3	5.0	6.3	2	4	A	2453	2693	2933	3173	6355	7355	8355
100	.22	20	.3	5.0	6.3	2	4	A	2454	2694	2934	3174	6356	7356	8356
100	.27	5	.3	5.0	6.3	2	4	A	5143	5343	5543	5743	6357	7357	8357
100	.27	10	.3	5.0	6.3	2	4	A	2455	2695	2935	3175	6358	7358	8358
100	.33	5	.3	5.0	6.3	2	4	A	5144	5344	5544	5744	6359	7359	8359
100	.33	10	.3	5.0	6.3	2	4	A	2456	2696	2936	3176	6360	7360	8360
100	.33	20	.3	5.0	6.3	2	4	A	2457	2697	2937	3177	6361	7361	8361
100	.39	5	.3	5.0	6.3	2	4	A	5145	5345	5545	5745	6362	7362	8362
100	.39	10	.3	5.0	6.3	2	4	A	2458	2698	2938	3178	6363	7363	8363
100	.47	5	.3	5.0	6.3	2	4	A	5146	5346	5546	5746	6364	7364	8364
100	.47	10	.3	5.0	6.3	2	4	A	2459	2699	2939	3179	6365	7365	8365
100	.47	20	.3	5.0	6.3	2	4	A	2460	2700	2940	3180	6366	7366	8366
100	.56	5	.3	5.0	6.3	2	4	A	5147	5347	5547	5747	6367	7367	8367
100	.56	10	.3	5.0	6.3	2	4	A	2461	2701	2941	3181	6368	7368	8368
100	.68	5	.3	5.0	6.3	2	4	B	5148	5348	5548	5748	6369	7369	8369
100	.68	10	.3	5.0	6.3	2	4	B	2462	2702	2942	3182	6370	7370	8370
100	.68	20	.3	5.0	6.3	2	4	B	2463	2703	2943	3183	6371	7371	8371
100	.82	5	.4	5.0	6.3	2	4	B	5149	5349	5549	5749	6372	7372	8372
100	.82	10	.4	5.0	6.3	2	4	B	2464	2704	2944	3184	6373	7373	8373
100	1.0	5	.5	5.0	6.3	2	4	B	5150	5350	5550	5750	6374	7374	8374
100	1.0	10	.5	5.0	6.3	2	4	B	2465	2705	2945	3185	6375	7375	8375
100	1.0	20	.5	5.0	6.3	2	4	B	2466	2706	2946	3186	6376	7376	8376
100	1.2	5	.5	5.0	6.3	4	4	B	5151	5351	5551	5751	6377	7377	8377
100	1.2	10	.5	5.0	6.3	4	4	B	2467	2707	2947	3187	6378	7378	8378
100	1.5	5	.7	10.0	13.0	4	4	B	5152	5352	5552	5752	6379	7379	8379
100	1.5	10	.7	10.0	13.0	4	4	B	2468	2708	2948	3188	6380	7380	8380
100	1.5	20	.7	10.0	13.0	4	4	B	2469	2709	2949	3189	6381	7381	8381
100	1.8	5	.7	10.0	13.0	4	4	B	5153	5353	5553	5753	6382	7382	8382
100	1.8	10	.7	10.0	13.0	4	4	B	2470	2710	2950	3190	6383	7383	8383
100	2.2	5	.9	15.0	19.0	4	4	B	5154	5354	5554	5754	6384	7384	8384
100	2.2	10	.9	15.0	19.0	4	4	B	2471	2711	2951	3191	6385	7385	8385
100	2.2	20	.9	15.0	19.0	4	4	B	2472	2712	2952	3192	6386	7386	8386
100	2.7	5	1.1	15.0	19.0	4	4	B	5155	5355	5555	5755	6387	7387	8387
100	2.7	10	1.1	15.0	19.0	4	4	B	2473	2713	2953	3193	6388	7388	8388
100	3.3	5	1.5	30.0	38.0	6	6	C	5156	5356	5556	5756	6389	7389	8389
100	3.3	10	1.5	30.0	38.0	6	6	C	5157	5357	5557	5757	6390	7390	8390
100	3.3	20	1.5	30.0	38.0	6	6	C	5158	5358	5558	5758	6391	7391	8391
100	3.9	5	1.5	30.0	38.0	6	6	C	5159	5359	5559	5759	6392	7392	8392
100	3.9	10	1.5	30.0	38.0	6	6	C	5160	5360	5560	5760	6393	7393	8393
100	4.7	5	2.5	50.0	63.0	6	6	C	5161	5361	5561	5761	6394	7394	8394
100	4.7	10	2.5	50.0	63.0	6	6	C	5162	5362	5562	5762	6395	7395	8395
100	4.7	20	2.5	50.0	63.0	6	6	C	5163	5363	5563	5763	6396	7396	8396
100	5.6	5	2.5	50.0	63.0	6	6	C	5164	5364	5564	5764	6397	7397	8397
100	5.6	10	2.5	50.0	63.0	6	6	C	5165	5365	5565	5765	6398	7398	8398
100	6.8	5	2.5	50.0	63.0	6	6	C	5166	5366	5566	5766	6399	7399	8399
100	6.8	10	2.5	50.0	63.0	6	6	C	5167	5367	5567	5767	6400	7400	8400
100	6.8	20	2.5	50.0	63.0	6	6	C	5168	5368	5568	5768	6401	7401	8401

MIL-C-39003/09
STYLE CSR21

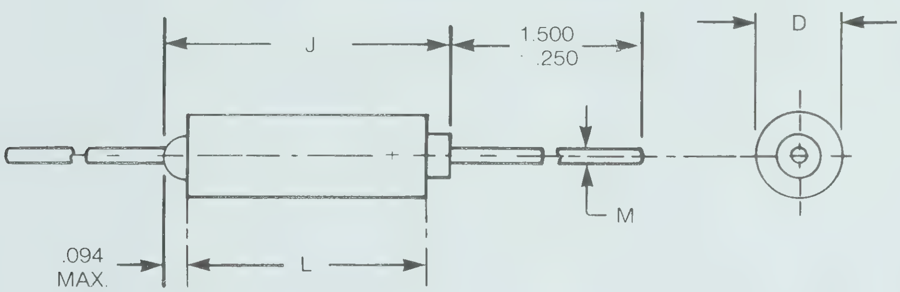
PART NUMBER SYSTEM

EXAMPLE M39003 /09 −0042

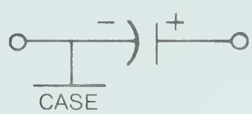
- −0042 — Dash # assigned for each specific value of capacitance voltage, capacitance tolerance, and failure rate level. See table for specific rating.
- /09 — Detail sheet for specific style — CSR 21
- M39003 — MIL-C-39003 — Generic specification for established reliability solid tantalum capacitors.

NOTE: *Military number does not specify capacitance voltage, capacitance tolerance, failure rate, or case size. See table.*

OUTLINE DRAWING AND DIMENSIONS



CIRCUIT DIAGRAM



CASE SIZE	Dimensions — Inches (mm)			
	L ±.031 (.79)	D +.016 (.41) −.015 (.38)	M ±.002 (.05)	J max.
C	0.686 (17.42)	0.289 (7.34)	0.025 (0.64)	0.822 (20.88)
D	0.786 (19.96)	0.351 (8.92)	0.025 (0.64)	0.922 (23.42)

NOTES:

1. The case insulation shall extend .015″ (0.38mm) minimum beyond each end. However, when a shrink-fitted insulation is used, it shall lap over the ends of the capacitor body.
2. Lead length may be a minimum of 1-inch long for use in tape and reel automatic insertion equipment, when specified.
3. Insulation thickness is included in dimension D.

MIL-C-39003

Military Style Tantalum Capacitors

MIL-C-39003/09
STYLE CSR21

DC rated voltage	Capaci-tance	Capaci-tance tolerance	DC leakage at			Dissi-pation factor 1 kHz +25°C	ESR 100 kHz +25°C (max)	Ripple current 40 kHz 25°C (max)	Derated ripple current 1 KHz 25°C (max)	Case size	Part no. M39003/09- Failure rate level for (%/1,000 hrs)						
			+25°C	+85°C	+125°C						M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	μF	Percent	μA	μA	μA	Percent	Ohms	A									
6	150	5	4.5	90	113	10	.065	3.3	2.0	C	0001	0101	0201	0301	2001	3001	4001
6	150	10	4.5	90	113	10	.065	3.3	2.0	C	0002	0102	0202	0302	2002	3002	4002
6	150	20	4.5	90	113	10	.065	3.3	2.0	C	0003	0103	0203	0303	2003	3003	4003
6	180	5	5.5	110	138	10	.060	3.4	2.4	C	0004	0104	0204	0304	2004	3004	4004
6	180	10	5.5	110	138	10	.060	3.4	2.4	C	0005	0105	0205	0305	2005	3005	4005
6	270	5	6.5	130	163	10	.050	4.1	3.4	D	0006	0106	0206	0306	2006	3006	4006
6	270	10	6.5	130	163	10	.050	4.1	3.4	D	0007	0107	0207	0307	2007	3007	4007
6	330	5	7.5	150	188	12	.045	4.3	3.8	D	0008	0108	0208	0308	2008	3008	4008
6	330	10	7.5	150	188	12	.045	4.3	3.8	D	0009	0109	0209	0309	2009	3009	4009
6	330	20	7.5	150	188	12	.045	4.3	3.8	D	0010	0110	0210	0310	2010	3010	4010
10	82	5	4	80	100	8	.085	2.9	1.8	C	0011	0111	0211	0311	2011	3011	4011
10	82	10	4	80	100	8	.085	2.9	1.8	C	0012	0112	0212	0312	2012	3012	4012
10	100	5	5	100	125	8	.075	3.0	2.2	C	0013	0113	0213	0313	2013	3013	4013
10	100	10	5	100	125	8	.075	3.0	2.2	C	0014	0114	0214	0314	2014	3014	4014
10	100	20	5	100	125	8	.075	3.0	2.2	C	0015	0115	0215	0315	2015	3015	4015
10	120	5	6	120	150	8	.070	3.2	2.5	C	0016	0116	0216	0316	2016	3016	4016
10	120	10	6	120	150	8	.070	3.2	2.5	C	0017	0117	0217	0317	2017	3017	4017
10	180	5	9	180	226	8	.060	3.7	3.4	D	0018	0118	0218	0318	2018	3018	4018
10	180	10	9	180	226	8	.060	3.7	3.4	D	0019	0119	0219	0319	2019	3019	4019
10	220	5	10	200	250	10	.055	3.9	3.4	D	0020	0120	0220	0320	2020	3020	4020
10	220	10	10	200	250	10	.055	3.9	3.4	D	0021	0121	0221	0321	2021	3021	4021
10	220	20	10	200	250	10	.055	3.9	3.4	D	0022	0122	0222	0322	2022	3022	4022
15	56	5	4	80	100	6	.100	2.6	1.8	C	0023	0123	0223	0323	2023	3023	4023
15	56	10	4	80	100	6	.100	2.6	1.8	C	0024	0124	0224	0324	2024	3024	4024
15	68	5	5	100	125	6	.095	2.7	2.2	C	0025	0125	0225	0325	2025	3025	4025
15	68	10	5	100	125	6	.095	2.7	2.2	C	0026	0126	0226	0326	2026	3026	4026
15	68	20	5	100	226	6	.095	2.7	2.2	C	0027	0127	0227	0327	2027	3027	4027
15	120	5	9	180	226	8	.070	3.5	2.8	D	0028	0128	0228	0328	2028	3028	4028
15	120	10	9	180	226	8	.070	3.5	2.8	D	0029	0129	0229	0329	2029	3029	4029
15	150	5	10	200	250	8	.065	3.6	3.1	D	0030	0130	0230	0330	2030	3030	4030
15	150	10	10	200	250	8	.065	3.6	3.1	D	0031	0131	0231	0331	2031	3031	4031
15	150	20	10	200	250	8	.065	3.6	3.1	D	0032	0132	0232	0332	2032	3032	4032
20	27	5	2.5	50	63	5	.145	2.2	1.2	C	0033	0133	0233	0333	2033	3033	4033
20	27	10	2.5	50	63	5	.145	2.2	1.2	C	0034	0134	0234	0334	2034	3034	4034
20	33	5	3.5	70	88	5	.130	2.3	1.4	C	0035	0135	0235	0335	2035	3035	4035
20	33	10	3.5	70	88	5	.130	2.3	1.4	C	0036	0136	0236	0336	2036	3036	4036
20	33	20	3.5	70	88	5	.130	2.3	1.4	C	0037	0137	0237	0337	2037	3037	4037
20	39	5	4.0	80	100	5	.120	2.4	1.7	C	0038	0138	0238	0338	2038	3038	4038
20	39	10	4.0	80	100	5	.120	2.4	1.7	C	0039	0139	0239	0339	2039	3039	4039
20	47	5	4.5	90	113	6	.110	2.5	1.8	C	0040	0140	0240	0340	2040	3040	4040
20	47	10	4.5	90	113	6	.110	2.5	1.8	C	0041	0141	0241	0341	2041	3041	4041

MIL-C-39003/09
STYLE CSR21

DC rated voltage	Capacitance	Capacitance tolerance	DC leakage at +25°C	DC leakage at +85°C	DC leakage at +125°C	Dissipation factor 1 kHz +25°C	ESR 100 kHz +25°C (max)	Ripple current 40 kHz 25°C (max)	Derated ripple current 1 KHz 25°C (max)	Case size	Part no. M39003/09- Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	μF	Percent	μA	μA	μA	Percent	Ohms	A									
20	47	20	4.5	90	113	6	.110	2.5	1.8	C	0042	0142	0242	0342	2042	3042	4042
20	56	5	5.5	110	138	6	.100	2.9	2.2	D	0043	0143	0243	0343	2043	3043	4043
20	56	10	5.5	110	138	6	.100	2.9	2.2	D	0044	0144	0244	0344	2044	3044	4044
20	68	5	7	140	175	6	.095	3.0	2.4	D	0045	0145	0245	0345	2045	3045	4045
20	68	10	7	140	175	6	.095	3.0	2.4	D	0046	0146	0246	0346	2046	3046	4046
20	68	20	7	140	175	6	.095	3.0	2.4	D	0047	0147	0247	0347	2047	3047	4047
20	82	5	8	160	200	6	.085	3.1	2.5	D	0048	0148	0248	0348	2048	3048	4048
20	82	10	8	160	200	6	.085	3.1	2.5	D	0049	0149	0249	0349	2049	3049	4049
20	100	5	10	200	250	8	.075	3.3	2.5	D	0050	0150	0250	0350	2050	3050	4050
20	100	10	10	200	250	8	.075	3.3	2.5	D	0051	0151	0251	0351	2051	3051	4051
20	100	20	10	200	250	8	.075	3.3	2.5	D	0052	0152	0252	0352	2052	3052	4052
35	22	5	4	80	100	4	.160	2.1	1.5	C	0053	0153	0253	0353	2053	3053	4053
35	22	10	4	80	100	4	.160	2.1	1.5	C	0054	0154	0254	0354	2054	3054	4054
35	22	20	4	80	100	4	.160	2.1	1.5	C	0055	0155	0255	0355	2055	3055	4055
35	27	5	4.5	90	113	4	.145	2.4	1.9	D	0056	0156	0256	0356	2056	3056	4056
35	27	10	4.5	90	113	4	.145	2.4	1.9	D	0057	0157	0257	0357	2057	3057	4057
35	33	5	5.5	110	138	5	.130	2.5	1.9	D	0058	0158	0258	0358	2058	3058	4058
35	33	10	5.5	110	138	5	.130	2.5	1.9	D	0059	0159	0259	0359	2059	3059	4059
35	33	20	5.5	110	138	5	.130	2.5	1.9	D	0060	0160	0260	0360	2060	3060	4060
35	39	5	7	140	175	5	.120	2.6	2.0	D	0061	0161	0261	0361	2061	3061	4061
35	39	10	7	140	175	5	.120	2.6	2.0	D	0062	0162	0262	0362	2062	3062	4062
35	47	5	8	160	200	5	.110	2.7	2.2	D	0063	0163	0263	0363	2063	3063	4063
35	47	10	8	160	200	5	.110	2.7	2.2	D	0064	0164	0264	0364	2064	3064	4064
35	47	20	8	160	200	5	.110	2.7	2.2	D	0065	0165	0265	0365	2065	3065	4065
50	5.6	5	2.2	45	56	3	.300	1.5	.6	C	0066	0166	0266	0366	2066	3066	4066
50	5.6	10	2.2	45	56	3	.300	1.5	.6	C	0067	0167	0267	0367	2067	3067	4067
50	6.8	5	2.2	45	56	3	.275	1.6	.7	C	0068	0168	0268	0368	2068	3068	4068
50	6.8	10	2.2	45	56	3	.275	1.6	.7	C	0069	0169	0269	0369	2069	3069	4069
50	6.8	20	2.2	45	56	3	.275	1.6	.7	C	0070	0170	0270	0370	2070	3070	4070
50	8.2	5	2.5	50	63	3	.250	1.6	.9	C	0071	0171	0271	0371	2071	3071	4071
50	8.2	10	2.5	50	63	3	.250	1.6	.9	C	0072	0172	0272	0372	2072	3072	4072
50	10	5	2.5	50	63	3	.230	1.7	1.1	C	0073	0173	0273	0373	2073	3073	4073
50	10	10	2.5	50	63	3	.230	1.7	1.1	C	0074	0174	0274	0374	2074	3074	4074
50	10	20	2.5	50	63	3	.230	1.7	1.1	C	0075	0175	0275	0375	2075	3075	4075
50	12	5	3	60	75	3	.210	1.8	1.3	C	0076	0176	0276	0376	2076	3076	4076
50	12	10	3	60	75	3	.210	1.8	1.3	C	0077	0177	0277	0377	2077	3077	4077
50	15	5	4	80	100	3	.190	1.9	1.4	C	0078	0178	0278	0378	2078	3078	4078
50	15	10	4	80	100	3	.190	1.9	1.4	C	0079	0179	0279	0379	2079	3079	4079
50	15	20	4	80	100	3	.190	1.9	1.4	C	0080	0180	0280	0380	2080	3080	4080
50	18	5	4.5	90	113	4	.175	2.0	1.4	C	0081	0181	0281	0381	2081	3081	4081
50	18	10	4.5	90	113	4	.175	2.0	1.4	C	0082	0182	0282	0382	2082	3082	4082
50	22	5	5.5	110	138	4	.160	2.3	1.7	D	0083	0183	0283	0383	2083	3083	4083
50	22	10	5.5	110	138	4	.160	2.3	1.7	D	0084	0184	0284	0384	2084	3084	4084
50	22	20	5.5	110	138	4	.160	2.3	1.7	D	0085	0185	0285	0385	2085	3085	4085

MIL-C-39003

Military Style Tantalum Capacitors

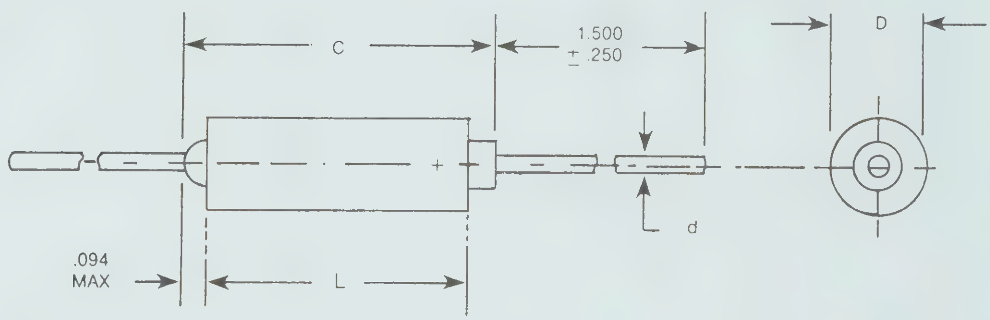
MIL-C-39003/03
STYLE CSR23

MILITARY CODING SYSTEM

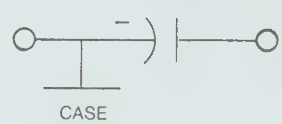
M39003 /03 —0001

- —0001: Dash number assigned for each specific value of capacitance-voltage, capacitance tolerance, and failure rate level. See table for specific rating.
- /03: Detail sheet for specific style — CSR23
- M39003: MIL-C-39003 — Generic specification for established reliability solid tantalum capacitors.

NOTE: *Military number does not specify capacitance, voltage, capacitance, tolerance, failure rate, or case size. See table.*



CIRCUIT DIAGRAM



CASE SIZE	Dimensions — Inches (mm)			
	L ±.031 (.79)	D +.016 (.41) −.015 (.38)	d ±.002 (.05)	C max.
A	0.286 (7.26)	0.135 (3.43)	0.020 (0.51)	0.422 (10.72)
B	0.474 (12.04)	0.185 (4.70)	0.020 (0.51)	0.610 (15.49)
C	0.686 (17.42)	0.289 (7.34)	0.025 (0.64)	0.822 (20.88)
D	0.786 (19.96)	0.351 (8.92)	0.025 (0.64)	0.922 (23.42)

MIL-C-39003/03
STYLE CSR23

DC rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage at +25°C	DC leakage at +85°C	DC leakage at +125°C	Dissipation factor at −55°C	Dissipation factor at +25°C	Case size	Part no. M39003/03- Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	μF	Percent	μA	μA	μA	Percent	Percent								
6	10.0	10	0.9	9.0	11.0	6	6	A	0101	0201	0301	0401	2001	3001	4001
6	10.0	20	0.9	9.0	11.0	6	6	A	0102	0202	0302	0402	2002	3002	4002
6	12.0	10	1.0	10.0	12.5	6	6	A	0103	0203	0303	0403	2003	3003	4003
6	100.0	10	6.0	60.0	75.0	8	8	B	0104	0204	0304	0404	2004	3004	4004
6	100.0	20	6.0	60.0	75.0	8	8	B	0105	0205	0305	0405	2005	3005	4005
6	330.0	10	15.0	150.0	188.0	8	8	C	0106	0206	0306	0406	2006	3006	4006
6	330.0	20	15.0	150.0	188.0	8	8	C	0107	0207	0307	0407	2007	3007	4007
6	390.0	10	15.0	150.0	188.0	10	10	C	0108	0208	0308	0408	2008	3008	4008
6	470.0	10	15.0	150.0	188.0	10	10	C	0109	0209	0309	0409	2009	3009	4009
6	470.0	20	15.0	150.0	188.0	10	10	C	0110	0210	0310	0410	2010	3010	4010
6	680.0	10	20.0	200.0	250.0	10	10	D	0111	0211	0311	0411	2011	3011	4011
6	680.0	20	20.0	200.0	250.0	10	10	D	0112	0212	0312	0412	2012	3012	4012
6	820.0	10	20.0	200.0	250.0	10	10	D	0113	0213	0313	0413	2013	3013	4013
6	1000.0	10	30.0	300.0	375.0	10	10	D	0114	0214	0314	0414	2014	3014	4014
6	1000.0	20	30.0	300.0	375.0	10	10	D	0115	0215	0315	0415	2015	3015	4015
10	6.8	10	1.0	10.0	12.5	6	6	A	0116	0216	0316	0416	2016	3016	4016
10	6.8	20	1.0	10.0	12.5	6	6	A	0117	0217	0317	0417	2017	3017	4017
10	8.2	10	1.2	12.0	15.0	6	6	A	0118	0218	0318	0418	2018	3018	4018
10	47.0	10	5.0	50.0	63.0	6	6	B	0119	0219	0319	0419	2019	3019	4019
10	47.0	20	5.0	50.0	63.0	6	6	B	0120	0220	0320	0420	2020	3020	4020
10	56.0	10	6.0	60.0	75.0	6	6	B	0121	0221	0321	0421	2021	3021	4021
10	68.0	10	7.0	70.0	88.0	6	6	B	0122	0222	0322	0422	2022	3022	4022
10	68.0	20	7.0	70.0	88.0	6	6	B	0123	0223	0323	0423	2023	3023	4023
10	82.0	10	8.0	80.0	100.0	6	6	B	0124	0224	0324	0424	2024	3024	4024
10	220.0	10	15.0	150.0	188.0	8	8	C	0125	0225	0325	0425	2025	3025	4025
10	220.0	20	15.0	150.0	188.0	8	8	C	0126	0226	0326	0426	2026	3026	4026
10	270.0	10	15.0	150.0	188.0	8	8	C	0127	0227	0327	0427	2027	3027	4027
10	390.0	10	20.0	200.0	250.0	10	10	D	0128	0228	0328	0428	2028	3028	4028
10	470.0	10	20.0	200.0	250.0	10	10	D	0129	0229	0329	0429	2029	3029	4029
10	470.0	20	20.0	200.0	250.0	10	10	D	0130	0230	0330	0430	2030	3030	4030
10	560.0	10	30.0	300.0	375.0	10	10	D	0131	0231	0331	0431	2031	3031	4031
15	4.7	10	1.0	10.0	12.5	4	4	A	0132	0232	0332	0432	2032	3032	4032
15	4.7	20	1.0	10.0	12.5	4	4	A	0133	0233	0333	0433	2033	3033	4033
15	5.6	10	1.3	13.0	16.5	4	4	A	0134	0234	0334	0434	2034	3034	4034
15	33.0	10	6.0	60.0	75.0	6	6	B	0135	0235	0335	0435	2035	3035	4035
15	33.0	20	6.0	60.0	75.0	6	6	B	0136	0236	0336	0436	2036	3036	4036
15	39.0	10	6.0	60.0	75.0	6	6	B	0137	0237	0337	0437	2037	3037	4037
15	150.0	10	15.0	150.0	188.0	8	8	C	0138	0238	0338	0438	2038	3038	4038
15	150.0	20	15.0	150.0	188.0	8	8	C	0139	0239	0339	0439	2039	3039	4039
15	180.0	10	15.0	150.0	188.0	8	8	C	0140	0240	0340	0440	2040	3040	4040
15	220.0	10	20.0	200.0	250.0	8	8	D	0141	0241	0341	0441	2041	3041	4041
15	220.0	20	20.0	200.0	250.0	8	8	D	0142	0242	0342	0442	2042	3042	4042
15	270.0	10	20.0	200.0	250.0	8	8	D	0143	0243	0343	0443	2043	3043	4043
15	330.0	10	20.0	200.0	250.0	8	8	D	0144	0244	0344	0444	2044	3044	4044
15	330.0	20	20.0	200.0	250.0	8	8	D	0145	0245	0345	0445	2045	3045	4045

MIL-C-39003

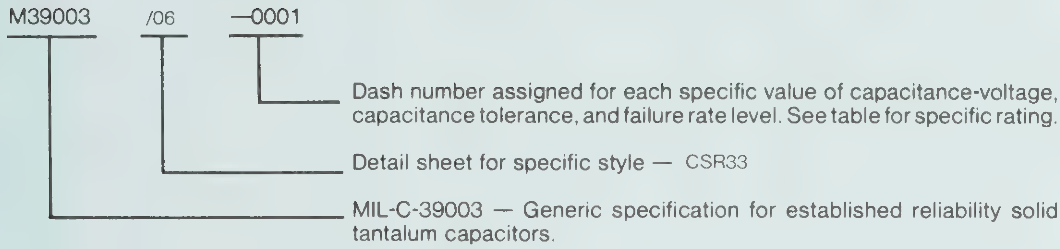
Military Style Tantalum Capacitors

MIL-C-39003/03
STYLE CSR23

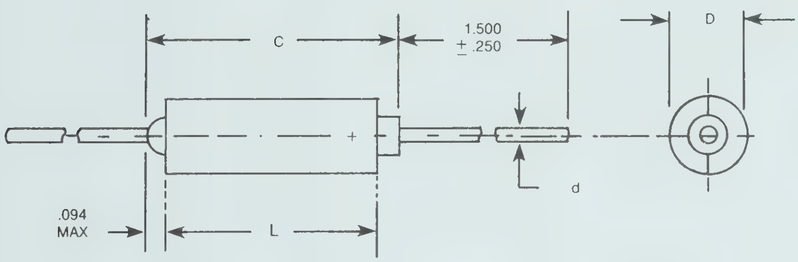
DC rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage at +25°C	DC leakage at +85°C	DC leakage at +125°C	Dissipation factor at −55°C	Dissipation factor at +25°C	Case size	Part no. M39003/03- Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	µF	Percent	µA	µA	µA	Percent	Percent								
20	2.7	10	0.8	8.0	10.0	4	4	A	0146	0246	0346	0446	2046	3046	4046
20	3.3	10	1.0	10.0	12.5	4	4	A	0147	0247	0347	0447	2047	3047	4047
20	3.3	20	1.0	10.0	12.5	4	4	A	0148	0248	0348	0448	2048	3048	4048
20	3.9	10	1.2	12.0	15.0	4	4	A	0149	0249	0349	0449	2049	3049	4049
20	18.0	10	4.0	40.0	50.0	6	6	B	0150	0250	0350	0450	2050	3050	4050
20	22.0	10	4.0	40.0	50.0	6	6	B	0151	0251	0351	0451	2051	3051	4051
20	22.0	20	4.0	40.0	50.0	6	6	B	0152	0252	0352	0452	2052	3052	4052
20	27.0	10	5.0	50.0	63.0	6	6	B	0153	0253	0353	0453	2053	3053	4053
20	56.0	10	9.0	90.0	110.0	6	6	C	0154	0254	0354	0454	2054	3054	4054
20	68.0	10	10.0	100.0	125.0	6	6	C	0155	0255	0355	0455	2055	3055	4055
20	68.0	20	10.0	100.0	125.0	6	6	C	0156	0256	0356	0456	2056	3056	4056
20	82.0	10	10.0	100.0	125.0	6	6	C	0157	0257	0357	0457	2057	3057	4057
20	100.0	10	15.0	150.0	188.0	6	6	C	0158	0258	0358	0458	2058	3058	4058
20	100.0	20	15.0	150.0	188.0	6	6	C	0159	0259	0359	0459	2059	3059	4059
20	120.0	10	15.0	150.0	188.0	6	6	C	0160	0260	0360	0460	2060	3060	4060
20	150.0	10	20.0	200.0	250.0	8	8	D	0161	0261	0361	0461	2061	3061	4061
20	150.0	20	20.0	200.0	250.0	8	8	D	0162	0262	0362	0462	2062	3062	4062
20	180.0	10	20.0	200.0	250.0	8	8	D	0163	0263	0363	0463	2063	3063	4063
35	1.8	10	1.0	10.0	12.5	4	4	A	0164	0264	0364	0464	2064	3064	4064
35	8.2	10	3.5	35.0	44.0	6	6	B	0165	0265	0365	0465	2065	3065	4065
35	10.0	10	4.0	40.0	50.0	6	6	B	0166	0266	0366	0466	2066	3066	4066
35	10.0	20	4.0	40.0	50.0	6	6	B	0167	0267	0367	0467	2067	3067	4067
35	33.0	10	10.0	100.0	125.0	6	6	C	0168	0268	0368	0468	2068	3068	4068
35	33.0	20	10.0	100.0	125.0	6	6	C	0169	0269	0369	0469	2069	3069	4069
35	39.0	10	10.0	100.0	125.0	6	6	C	0170	0270	0370	0470	2070	3070	4070
35	47.0	10	10.0	100.0	125.0	6	6	C	0171	0271	0371	0471	2071	3071	4071
35	47.0	20	10.0	100.0	125.0	6	6	C	0172	0272	0372	0472	2072	3072	4072
35	56.0	10	15.0	150.0	188.0	6	6	D	0173	0273	0373	0473	2073	3073	4073
35	68.0	10	15.0	150.0	188.0	6	6	D	0174	0274	0374	0474	2074	3074	4074
35	68.0	20	15.0	150.0	188.0	6	6	D	0175	0275	0375	0475	2075	3075	4075
50	1.2	10	0.9	9.0	11.0	4	4	A	0176	0276	0376	0476	2076	3076	4076
50	1.5	10	1.2	12.0	15.0	4	4	A	0177	0277	0377	0477	2077	3077	4077
50	1.5	20	1.2	12.0	15.0	4	4	A	0178	0278	0378	0478	2078	3078	4078
50	5.6	10	4.5	45.0	56.0	4	4	B	0179	0279	0379	0479	2079	3079	4079
50	6.8	10	4.5	45.0	56.0	6	6	B	0180	0280	0380	0480	2080	3080	4080
50	6.8	20	4.5	45.0	56.0	6	6	B	0181	0281	0381	0481	2081	3081	4081
50	22.0	10	10.0	100.0	125.0	6	6	C	0182	0282	0382	0482	2082	3082	4082
50	22.0	20	10.0	100.0	125.0	6	6	C	0183	0283	0383	0483	2083	3083	4083
50	27.0	10	10.0	100.0	125.0	6	6	C	0184	0284	0384	0484	2084	3084	4084
50	33.0	10	10.0	100.0	125.0	6	6	D	0185	0285	0385	0485	2085	3085	4085
50	33.0	20	10.0	100.0	125.0	6	6	D	0186	0286	0386	0486	2086	3086	4086
50	39.0	10	10.0	100.0	125.0	6	6	D	0187	0287	0387	0487	2087	3087	4087

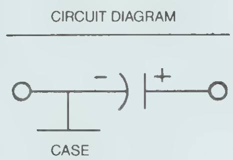
MIL-C-39003/06
STYLE CSR33

MILITARY CODING SYSTEM



NOTE: *Military number does not specify capacitance, voltage, capacitance, tolerance, failure rate, or case size. See table.*





CASE SIZE	Dimensions — Inches (mm)			
	L ±.031 (.79)	D +.016 (.41) −.015 (.38)	d ±.002 (.05)	C max.
A	0.286 (7.26)	0.135 (3.43)	0.020 (0.51)	0.422 (10.72)
B	0.474 (12.04)	0.185 (4.70)	0.020 (0.51)	0.610 (15.49)
C	0.686 (17.42)	0.289 (7.34)	0.025 (0.64)	0.822 (20.88)
D	0.786 (19.96)	0.351 (8.92)	0.025 (0.64)	0.922 (23.42)

MIL-C-39003

Military Style Tantalum Capacitors

MIL-C-39003/06
STYLE CSR33

DC rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage at			Dissipation factor at		Case size	Part no. M39003/06- Failure rate level for (%/1,000 hrs)						
			+25°C	+85°C	+125°C	−55°C +25°C	+85°C +125°C		M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	µF	Percent	µA	µA	µA	Percent	Percent								
6	10.0	10	0.5	2.0	2.0	6	6	A	0001	0101	0201	0301	2001	3001	4001
6	10.0	20	0.5	2.0	2.0	6	6	A	0002	0102	0202	0302	2002	3002	4002
6	12.0	10	0.5	2.0	2.0	6	6	A	0003	0103	0203	0303	2003	3003	4003
6	100.0	10	1.0	3.0	3.0	8	8	B	0004	0104	0204	0304	2004	3004	4004
6	100.0	20	1.0	3.0	3.0	8	8	B	0005	0105	0205	0305	2005	3005	4005
6	330.0	10	2.0	8.0	8.0	8	8	C	0006	0106	0206	0306	2006	3006	4006
6	330.0	20	2.0	8.0	8.0	8	8	C	0007	0107	0207	0307	2007	3007	4007
6	390.0	10	2.0	8.0	8.0	10	10	C	0008	0108	0208	0308	2008	3008	4008
6	470.0	10	2.0	8.0	8.0	10	10	C	0009	0109	0209	0309	2009	3009	4009
6	470.0	20	2.0	8.0	8.0	10	10	C	0010	0110	0210	0310	2010	3010	4010
6	680.0	10	5.0	10.0	10.0	10	10	D	0011	0111	0211	0311	2011	3011	4011
6	680.0	20	5.0	10.0	10.0	10	10	D	0012	0112	0212	0312	2012	3012	4012
6	820.0	10	5.0	10.0	10.0	10	10	D	0013	0113	0213	0313	2013	3013	4013
6	1000.0	10	5.0	10.0	10.0	10	10	D	0014	0114	0214	0314	2014	3014	4014
6	1000.0	20	5.0	10.0	10.0	10	10	D	0015	0115	0215	0315	2015	3015	4015
10	6.8	10	.5	2.0	2.0	6	6	A	0016	0116	0216	0316	2016	3016	4016
10	6.8	20	.5	2.0	2.0	6	6	A	0017	0117	0217	0317	2017	3017	4017
10	8.2	10	.5	2.0	2.0	6	6	A	0018	0118	0218	0318	2018	3018	4018
10	47.0	10	1.0	2.0	2.0	6	6	B	0019	0119	0219	0319	2019	3019	4019
10	47.0	20	1.0	2.0	2.0	6	6	B	0020	0120	0220	0320	2020	3020	4020
10	56.0	10	1.0	4.0	4.0	6	6	B	0021	0121	0221	0321	2021	3021	4021
10	68.0	10	1.0	4.0	4.0	6	6	B	0022	0122	0222	0322	2022	3022	4022
10	68.0	20	1.0	4.0	4.0	6	6	B	0023	0123	0223	0323	2023	3023	4023
10	82.0	10	1.0	4.0	4.0	6	6	B	0024	0124	0224	0324	2024	3024	4024
10	220.0	10	1.0	7.0	7.0	8	8	C	0025	0125	0225	0325	2025	3025	4025
10	220.0	20	1.0	7.0	7.0	8	8	C	0026	0126	0226	0326	2026	3026	4026
10	270.0	10	2.0	10.0	10.0	8	8	C	0027	0127	0227	0327	2027	3027	4027
10	390.0	10	2.0	16.0	16.0	10	10	D	0028	0128	0228	0328	2028	3028	4028
10	470.0	10	4.0	16.0	16.0	10	10	D	0029	0129	0229	0329	2029	3029	4029
10	470.0	20	4.0	16.0	16.0	10	10	D	0030	0130	0230	0330	2030	3030	4030
10	560.0	10	4.0	16.0	16.0	10	10	D	0031	0131	0231	0331	2031	3031	4031
15	4.7	10	.5	2.0	2.0	4	4	A	0032	0132	0232	0332	2032	3032	4032
15	4.7	20	.5	2.0	2.0	4	4	A	0033	0133	0233	0333	2033	3033	4033
15	5.6	10	.5	2.0	2.0	4	4	A	0034	0134	0234	0334	2034	3034	4034
15	33.0	10	1.0	2.0	2.0	6	6	B	0035	0135	0235	0335	2035	3035	4035
15	33.0	20	1.0	2.0	2.0	6	6	B	0036	0136	0236	0336	2036	3036	4036
15	39.0	10	1.0	2.0	2.0	6	6	B	0037	0137	0237	0337	2037	3037	4037
15	150.0	10	1.0	7.0	7.0	8	8	C	0038	0138	0238	0338	2038	3038	4038
15	150.0	20	1.0	7.0	7.0	8	8	C	0039	0139	0239	0339	2039	3039	4039
15	180.0	10	2.0	10.0	10.0	8	8	C	0040	0140	0240	0340	2040	3040	4040
15	220.0	10	2.0	10.0	10.0	8	8	D	0041	0141	0241	0341	2041	3041	4041
15	220.0	20	2.0	10.0	10.0	8	8	D	0042	0142	0242	0342	2042	3042	4042
15	270.0	10	2.0	16.0	16.0	8	8	D	0043	0143	0243	0343	2043	3043	4043
15	330.0	10	2.0	16.0	16.0	8	8	D	0044	0144	0244	0344	2044	3044	4044
15	330.0	20	2.0	16.0	16.0	8	8	D	0045	0145	0245	0345	2045	3045	4045

MIL-C-39003/06
STYLE CSR33

DC rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage at +25°C	DC leakage at +85°C	DC leakage at +125°C	Dissipation factor at −55°C +25°C	Dissipation factor at +85°C +125°C	Case size	Part no. M39003/06- Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.1	C 0.01	D 0.001
Volts	µF	Percent	µA	µA	µA	Percent	Percent								
20	2.7	10	.5	2.0	2.0	4	4	A	0046	0146	0246	0346	2046	3046	4046
20	3.3	10	.5	2.0	2.0	4	4	A	0047	0147	0247	0347	2047	3047	4047
20	3.3	20	.5	2.0	2.0	4	4	A	0048	0148	0248	0348	2048	3048	4048
20	3.9	10	.5	2.0	2.0	4	4	A	0049	0149	0249	0349	2049	3049	4049
20	18.0	10	1.0	2.0	2.0	6	6	B	0050	0150	0250	0350	2050	3050	4050
20	22.0	10	1.0	2.0	2.0	6	6	B	0051	0151	0251	0351	2051	3051	4051
20	22.0	20	1.0	2.0	2.0	6	6	B	0052	0152	0252	0352	2052	3052	4052
20	27.0	10	1.0	2.0	2.0	6	6	B	0053	0153	0253	0353	2053	3053	4053
20	56.0	10	1.0	10.0	10.0	6	6	C	0054	0154	0254	0354	2054	3054	4054
20	68.0	10	1.0	10.0	10.0	6	6	C	0055	0155	0255	0355	2055	3055	4055
20	68.0	20	1.0	10.0	10.0	6	6	C	0056	0156	0256	0356	2056	3056	4056
20	82.0	10	1.0	10.0	10.0	6	6	C	0057	0157	0257	0357	2057	3057	4057
20	100.0	10	1.0	10.0	10.0	6	6	C	0058	0158	0258	0358	2058	3058	4058
20	100.0	20	1.0	10.0	10.0	6	6	C	0059	0159	0259	0359	2059	3059	4059
20	120.0	10	1.0	10.0	10.0	6	6	C	0060	0160	0260	0360	2060	3060	4060
20	150.0	10	2.0	10.0	10.0	8	8	D	0061	0161	0261	0361	2061	3061	4061
20	150.0	20	2.0	10.0	10.0	8	8	D	0062	0162	0262	0362	2062	3062	4062
20	180.0	10	2.0	10.0	10.0	8	8	D	0063	0163	0263	0363	2063	3063	4063
35	1.8	10	.5	2.0	2.0	4	4	A	0064	0164	0264	0364	2064	3064	4064
35	8.2	10	1.0	2.0	2.0	6	6	B	0065	0165	0265	0365	2065	3065	4065
35	10.0	10	1.0	2.0	2.0	6	6	B	0066	0166	0266	0366	2066	3066	4066
35	10.0	20	1.0	2.0	2.0	6	6	B	0067	0167	0267	0367	2067	3067	4067
35	33.0	10	1.0	5.0	5.0	6	6	C	0068	0168	0268	0368	2068	3068	4068
35	33.0	20	1.0	5.0	5.0	6	6	C	0069	0169	0269	0369	2069	3069	4069
35	39.0	10	1.0	5.0	5.0	6	6	C	0070	0170	0270	0370	2070	3070	4070
35	47.0	10	1.0	5.0	5.0	6	6	C	0071	0171	0271	0371	2071	3071	4071
35	47.0	20	1.0	5.0	5.0	6	6	C	0072	0172	0272	0372	2072	3072	4072
35	56.0	10	2.0	10.0	10.0	6	6	D	0073	0173	0273	0373	2073	3073	4073
35	68.0	10	2.0	10.0	10.0	6	6	D	0074	0174	0274	0374	2074	3074	4074
35	68.0	20	2.0	10.0	10.0	6	6	D	0075	0175	0275	0375	2075	3075	4075
50	1.2	10	.5	2.0	2.0	4	4	A	0076	0176	0276	0376	2076	3076	4076
50	1.5	10	.5	2.0	2.0	4	4	A	0077	0177	0277	0377	2077	3077	4077
50	1.5	20	.5	2.0	2.0	4	4	A	0078	0178	0278	0378	2078	3078	4078
50	5.6	10	1.0	2.0	2.0	4	4	B	0079	0179	0279	0379	2079	3079	4079
50	6.8	10	1.0	2.0	2.0	6	6	B	0080	0180	0280	0380	2080	3080	4080
50	6.8	20	1.0	2.0	2.0	6	6	B	0081	0181	0281	0381	2081	3081	4081
50	22.0	10	1.0	5.0	5.0	6	6	C	0082	0182	0282	0382	2082	3082	4082
50	22.0	20	1.0	5.0	5.0	6	6	C	0083	0183	0283	0383	2083	3083	4083
50	27.0	10	1.0	5.0	5.0	6	6	C	0084	0184	0284	0384	2084	3084	4084
50	33.0	10	1.0	9.0	9.0	6	6	D	0085	0185	0285	0385	2085	3085	4085
50	33.0	20	1.0	9.0	9.0	6	6	D	0086	0186	0286	0386	2086	3086	4086
50	39.0	10	1.0	9.0	9.0	6	6	D	0087	0187	0287	0387	2087	3087	4087

MIL-C-39003
Military Style Tantalum Capacitors

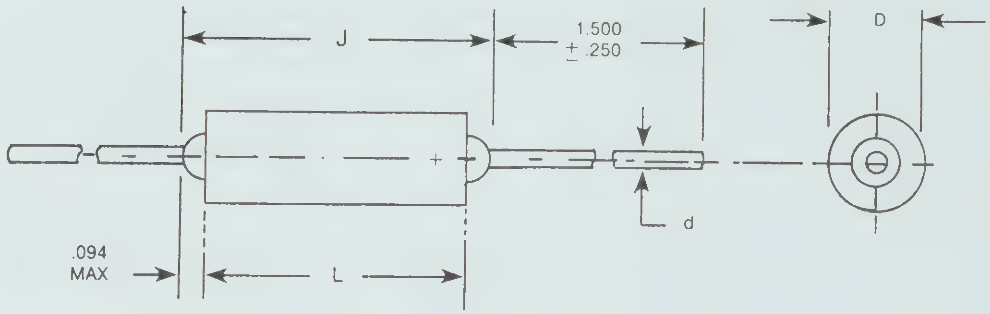
MIL-C-39003/04
STYLE CSR91
NON-POLAR

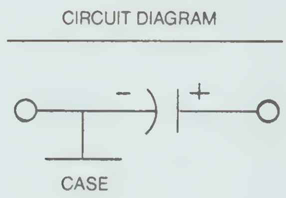
MILITARY CODING SYSTEM

M39003 /04 −1195

- −1195: Dash number assigned for each specific value of capacitance-voltage, capacitance tolerance, and failure rate level. See table for specific rating.
- /04: Detail sheet for specific style — CSR91.
- M39003: MIL-C-39003 — Generic specification for established reliability solid tantalum capacitors.

NOTE: *Military number does not specify capacitance, voltage, capacitance tolerance, failure rate, or case size. See table.*





CASE SIZE	Dimensions — Inches (mm)			
	L ±0.031 (0.79)	D +0.010 (0.25) −0.015 (0.38)	d ±0.002 (0.05)	J max.
W	0.575 (14.61)	0.161 (4.09)	0.020 (0.51)	0.750 (19.05)
X	0.955 (24.26)	0.207 (5.26)	0.020 (0.51)	1.130 (28.70)
Y	1.350 (34.29)	0.314 (7.98)	0.025 (0.64)	1.525 (38.74)
Z	1.550 (39.37)	0.376 (9.55)	0.025 (0.64)	1.725 (43.82)

1. The case insulation shall extend .015 (.38 mm) minimum beyond each end. However, when a shrink-fitted insulation is used, it shall lap over the ends of the capacitor body.
2. All CSR91 capacitors are insulated.

MIL-C-39003/04
STYLE CSR91
NON-POLAR

Rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage (max) +25°C	Dissipation factor (max) +25°C	Case size	Dash number Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.01	C 0.01	D 0.001
Volts, NP	µF	Percent	µA	Percent								
6	2.8	10	.3	4	W	0221	0441	0661	0881	3001	4001	5001
6	3.4	10	.3	6	W	0222	0442	0662	0882	3002	4002	5002
6	3.4	20	.3	6	W	0223	0443	0663	0883	3003	4003	5003
6	23.0	10	1.5	6	X	0224	0444	0664	0884	3004	4004	5004
6	23.0	20	1.5	6	X	0225	0445	0665	0885	3005	4005	5005
6	28.0	10	1.5	6	X	0226	0446	0666	0886	3006	4006	5006
6	75.0	10	4.5	8	Y	0227	0447	0667	0887	3007	4007	5007
6	75.0	20	4.5	8	Y	0228	0448	0668	0888	3008	4008	5008
6	90.0	10	5.5	8	Y	0229	0449	0669	0889	3009	4009	5009
6	130.0	10	6.5	8	Z	0231	0451	0671	0891	3010	4010	5010
6	160.0	10	7.5	8	Z	0233	0453	0673	0893	3011	4011	5011
6	160.0	20	7.5	8	Z	0234	0454	0674	0894	3012	4012	5012
10	1.9	10	.3	4	W	0235	0455	0675	0895	3013	4013	5013
10	2.3	10	.4	4	W	0236	0456	0676	0896	3014	4014	5014
10	2.3	20	.4	4	W	0237	0457	0677	0897	3015	4015	5015
10	13.0	10	2.0	6	X	0238	0458	0678	0898	3016	4016	5016
10	16.0	10	2.5	6	X	0239	0459	0679	0899	3017	4017	5017
10	16.0	20	2.5	6	X	0240	0460	0680	0900	3018	4018	5018
10	19.0	10	2.5	6	X	0241	0461	0681	0901	3019	4019	5019
10	41.0	10	4.0	6	Y	0242	0462	0682	0902	3020	4020	5020
10	50.0	10	5.0	8	Y	0243	0463	0683	0903	3021	4021	5021
10	50.0	20	5.0	8	Y	0244	0464	0684	0904	3022	4022	5022
10	60.0	10	6.0	8	Y	0245	0465	0685	0905	3023	4023	5023
10	90.0	10	9.0	8	Z	0247	0467	0687	0907	3024	4024	5024
10	110.0	10	10.0	8	Z	0248	0468	0688	0908	3025	4025	5025
10	110.0	20	10.0	8	Z	0249	0469	0689	0909	3026	4026	5026
15	1.3	10	.3	4	W	0250	0470	0690	0910	3027	4027	5027
15	1.6	10	.4	4	W	0251	0471	0691	0911	3028	4028	5028
15	1.6	20	.4	4	W	0252	0472	0692	0912	3029	4029	5029
15	9.0	10	2.0	6	X	0253	0473	0693	0913	3030	4030	5030
15	11.0	10	2.0	6	X	0254	0474	0694	0914	3031	4031	5031
15	11.0	20	2.0	6	X	0255	0475	0695	0915	3032	4032	5032
15	28.0	10	4.0	6	Y	0256	0476	0696	0916	3033	4033	5033
15	34.0	10	5.0	6	Y	0257	0477	0697	0917	3034	4034	5034
15	34.0	20	5.0	6	Y	0258	0478	0698	0918	3035	4035	5035
15	60.0	10	9.0	8	Z	0259	0479	0699	0919	3036	4036	5036
15	75.0	10	10.0	8	Z	0260	0480	0700	0920	3037	4037	5037
15	75.0	20	10.0	8	Z	0261	0481	0701	0921	3038	4038	5038
20	.6	10	.3	4	W	0262	0482	0702	0922	3039	4039	5039
20	.75	10	.3	4	W	0263	0483	0703	0923	3040	4040	5040
20	.75	20	.3	4	W	0264	0484	0704	0924	3041	4041	5041
20	.9	10	.3	4	W	0265	0485	0705	0925	3042	4042	5042
20	1.1	10	.4	4	W	0266	0486	0706	0926	3043	4043	5043
20	1.1	20	.4	4	W	0267	0487	0707	0927	3044	4044	5044
20	4.1	10	1.0	6	X	0268	0488	0708	0928	3045	4045	5045
20	5.0	10	1.5	6	X	0269	0489	0709	0929	3046	4046	5046
20	5.0	20	1.5	6	X	0270	0490	0710	0930	3047	4047	5047

MIL-C-39003

Military Style Tantalum Capacitors

MIL-C-39003/04
STYLE CSR91
NON-POLAR

Rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage (max) +25°C	Dissipation factor (max) +25°C	Case size	Dash number Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.01	C 0.01	D 0.001
Volts, NP	μF	Percent	μA	Percent								
20	6.0	10	1.8	6	X	0271	0491	0711	0931	3048	4048	5048
20	7.5	10	2.0	6	X	0272	0492	0712	0932	3049	4049	5049
20	7.5	20	2.0	6	X	0273	0493	0713	0933	3050	4050	5050
20	13	10	2.5	6	Y	0274	0494	0714	0934	3051	4051	5051
20	16	10	3.5	6	Y	0275	0495	0715	0935	3052	4052	5052
20	16	20	3.5	6	Y	0276	0496	0716	0936	3053	4053	5053
20	19	10	4.0	6	Y	0277	0497	0717	0937	3054	4054	5054
20	23	10	4.5	6	Y	0278	0498	0718	0938	3055	4055	5055
20	23	20	4.5	6	Y	0279	0499	0719	0939	3056	4056	5056
20	28	10	5.5	6	Z	0280	0500	0720	0940	3057	4057	5057
20	34	10	7.0	6	Z	0281	0501	0721	0941	3058	4058	5058
20	34	20	7.0	6	Z	0282	0502	0722	0942	3059	4059	5059
20	41	10	8.0	6	Z	0283	0503	0723	0943	3060	4060	5060
20	50	10	10.0	6	Z	0284	0504	0724	0944	3061	4061	5061
20	50	20	10.0	6	Z	0285	0505	0725	0945	3062	4062	5062
35	2.8	10	1.3	4	X	0289	0509	0729	0949	3063	4063	5063
35	3.4	10	1.5	6	X	0290	0510	0730	0950	3064	4064	5064
35	3.4	20	1.5	6	X	0291	0511	0731	0951	3065	4065	5065
35	11.0	10	4.0	6	Y	0292	0512	0732	0952	3066	4066	5066
35	11.0	20	4.0	6	Y	0293	0513	0733	0953	3067	4067	5067
35	13.0	10	4.5	6	Z	0294	0514	0734	0954	3068	4068	5068
35	16.0	10	5.5	6	Z	0295	0515	0735	0955	3069	4069	5069
35	16.0	20	5.5	6	Z	0296	0516	0736	0956	3070	4070	5070
35	19.0	10	7.0	6	Z	0297	0517	0737	0957	3071	4071	5071
35	23.0	10	8.0	6	Z	0298	0518	0738	0958	3072	4072	5072
35	23.0	20	8.0	6	Z	0299	0519	0739	0959	3073	4073	5073
50	.0023	10	.3	2	W	1171	1241	1311	1381	3074	4074	5074
50	.0023	20	.3	2	W	1172	1242	1312	1382	3075	4075	5075
50	.0028	10	.3	2	W	1173	1243	1313	1383	3076	4076	5076
50	.0034	10	.3	2	W	1174	1244	1314	1384	3077	4077	5077
50	.0034	20	.3	2	W	1175	1245	1315	1385	3078	4078	5078
50	.0041	10	.3	2	W	1176	1246	1316	1386	3079	4079	5079
50	.005	10	.3	2	W	1177	1247	1317	1387	3080	4080	5080
50	.005	20	.3	2	W	1178	1248	1318	1388	3081	4081	5081
50	.006	10	.3	2	W	1179	1249	1319	1389	3082	4082	5082
50	.0075	10	.3	2	W	1180	1250	1320	1390	3083	4083	5083
50	.0075	20	.3	2	W	1181	1251	1321	1391	3084	4084	5084
50	.009	10	.3	2	W	1182	1252	1322	1392	3085	4085	5085
50	.011	10	.3	2	W	1183	1253	1323	1393	3086	4086	5086
50	.011	20	.3	2	W	1184	1254	1324	1394	3087	4087	5087
50	.013	10	.3	2	W	1185	1255	1325	1395	3088	4088	5088
50	.016	10	.3	2	W	1186	1256	1326	1396	3089	4089	5089
50	.016	20	.3	2	W	1187	1257	1327	1397	3090	4090	5090
50	.019	10	.3	2	W	1188	1258	1328	1398	3091	4091	5091
50	.023	10	.3	2	W	1189	1259	1329	1399	3092	4092	5092
50	.023	20	.3	2	W	1190	1260	1330	1400	3093	4093	5093
50	.028	10	.3	2	W	1191	1261	1331	1401	3094	4094	5094
50	.034	10	.3	2	W	1192	1262	1332	1402	3095	4095	5095
50	.034	20	.3	2	W	1193	1263	1333	1403	3096	4096	5096
50	.041	10	.3	2	W	1194	1264	1334	1404	3097	4097	5097

MIL-C-39003/04
STYLE CSR91
NON-POLAR

Rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage (max) +25°C	Dissipation factor (max) +25°C	Case size	Dash number — Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.01	C 0.01	D 0.001
Volts, NP	µF	Percent	µA	Percent								
50	.05	10	.3	2	W	1195	1265	1335	1405	3098	4098	5098
50	.05	20	.3	2	W	1196	1266	1336	1406	3099	4099	5099
50	.06	10	.3	2	W	1197	1267	1337	1407	3100	4100	5100
50	.075	10	.3	2	W	1198	1268	1338	1408	3101	4101	5101
50	.075	20	.3	2	W	1199	1269	1339	1409	3102	4102	5102
50	.09	10	.3	2	W	1200	1270	1340	1410	3103	4103	5103
50	.11	10	.3	2	W	1201	1271	1341	1411	3104	4104	5104
50	.11	20	.3	2	W	1202	1272	1342	1412	3105	4105	5105
50	.13	10	.3	2	W	1203	1273	1343	1413	3106	4106	5106
50	.16	10	.3	2	W	1204	1274	1344	1414	3107	4107	5107
50	.16	20	.3	2	W	1205	1275	1345	1415	3108	4108	5108
50	.19	10	.3	2	W	1206	1276	1346	1416	3109	4109	5109
50	.23	10	.3	2	W	1207	1277	1347	1417	3110	4110	5110
50	.23	20	.3	2	W	1208	1278	1348	1418	3111	4111	5111
50	.28	10	.3	2	W	1209	1279	1349	1419	3112	4112	5112
50	.34	10	.3	2	W	1210	1280	1350	1420	3113	4113	5113
50	.34	20	.3	2	W	1211	1281	1351	1421	3114	4114	5114
50	.41	10	.3	2	W	0300	0520	0740	0960	3115	4115	5115
50	.50	10	.4	2	W	0301	0521	0741	0961	3116	4116	5116
50	.50	20	.4	2	W	0302	0522	0742	0962	3117	4117	5117
50	.60	10	.4	4	X	1212	1282	1352	1422	3118	4118	5118
50	.75	10	.6	4	X	2001	2101	2201	2301	3119	4119	5119
50	.75	20	.6	4	X	2002	2102	2202	2302	3120	4120	5120
50	.90	10	.7	4	X	1215	1285	1355	1425	3121	4121	5121
50	1.1	10	.8	4	X	1216	1286	1356	1426	3122	4122	5122
50	1.1	20	.8	4	X	1217	1287	1357	1427	3123	4123	5123
50	1.3	10	1.0	4	X	1218	1288	1358	1428	3124	4124	5124
50	1.6	10	1.2	4	X	1219	1289	1359	1429	3125	4125	5125
50	1.6	20	1.2	4	X	1220	1290	1360	1430	3126	4126	5126
50	1.9	10	1.5	4	X	1221	1291	1361	1431	3127	4127	5127
50	2.3	10	1.7	4	X	1222	1292	1362	1432	3128	4128	5128
50	2.3	20	1.7	4	X	1223	1293	1363	1433	3129	4129	5129
50	2.8	10	2.2	4	Y	1224	1294	1364	1434	3130	4130	5130
50	3.4	10	2.2	6	Y	1225	1295	1365	1435	3131	4131	5131
50	3.4	20	2.2	6	Y	1226	1296	1366	1436	3132	4132	5132
50	4.1	10	2.5	6	Y	1227	1297	1367	1437	3133	4133	5133
50	5.0	10	2.5	6	Y	1228	1298	1368	1438	3134	4134	5134
50	5.0	20	2.5	6	Y	1229	1299	1369	1439	3135	4135	5135
50	6.0	10	3.0	6	Y	0303	0523	0743	0963	3136	4136	5136
50	7.5	10	4.0	6	Y	0304	0524	0744	0964	3137	4137	5137
50	7.5	20	4.0	6	Y	0305	0525	0745	0965	3138	4138	5138
50	9.0	10	4.5	6	Y	0306	0526	0746	0966	3139	4139	5139
50	11.0	10	5.5	6	Z	0307	0527	0747	0967	3140	4140	5140
50	11.0	20	5.5	6	Z	0308	0528	0748	0968	3141	4141	5141
75	.34	10	.3	2	W	0309	0529	0749	0969	3142	4142	5142
75	.34	20	.3	2	W	0310	0530	0750	0970	3143	4143	5143
75	.41	10	.3	2	X	2008	2108	2208	2308	3144	4144	5144
75	.50	10	.4	2	X	2009	2109	2209	2309	3145	4145	5145
75	.50	20	.4	2	X	2010	2110	2210	2310	3146	4146	5146
75	.60	10	.4	4	X	2011	2111	2211	2311	3147	4147	5147

MIL-C-39003
Military Style Tantalum Capacitors

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Tantalum Capacitors

MIL-C-39003/04
STYLE CSR91
NON-POLAR

Rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage (max) +25°C	Dissipation factor (max) +25°C	Case size	Dash number: Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.01	C 0.01	D 0.001
Volts, NP	µF	Percent	µA	Percent								
75	.75	10	.6	4	X	2012	2112	2212	2312	3148	4148	5148
75	.75	20	.6	4	X	2013	2113	2213	2313	3149	4149	5149
75	.90	10	.7	4	X	2014	2114	2214	2314	3150	4150	5150
75	1.1	10	.8	4	X	2015	2115	2215	2315	3151	4151	5151
75	1.1	20	.8	4	X	2016	2116	2216	2316	3152	4152	5152
75	1.3	10	1.0	4	X	2017	2117	2217	2317	3153	4153	5153
75	1.6	10	1.2	4	X	0311	0531	0751	0971	3154	4154	5154
75	1.6	20	1.2	4	X	0312	0532	0752	0972	3155	4155	5155
75	1.9	10	1.5	4	X	0313	0533	0753	0973	3156	4156	5156
75	2.3	10	3.0	4	Y	2003	2103	2203	2303	3157	4157	5157
75	2.3	20	3.0	4	Y	2004	2104	2204	2304	3158	4158	5158
75	2.8	10	3.0	6	Y	2005	2105	2205	2305	3159	4159	5159
75	3.4	10	5.0	6	Y	2006	2106	2206	2306	3160	4160	5160
75	3.4	20	5.0	6	Y	2007	2107	2207	2307	3161	4161	5161
75	4.1	10	5.0	6	Y	0314	0534	0754	0974	3162	4162	5162
75	5.0	10	5.0	6	Y	0315	0535	0755	0975	3163	4163	5163
75	5.0	20	5.0	6	Y	0316	0536	0756	0976	3164	4164	5164
75	6.0	10	5.0	6	Z	0317	0537	0757	0977	3165	4165	5165
75	7.5	10	7.0	6	Z	0318	0538	0758	0978	3166	4166	5166
75	7.5	20	7.0	6	Z	0319	0539	0759	0979	3167	4167	5167
100	.0023	10	.3	2	W	0320	0540	0760	0980	3168	4168	5168
100	.0023	20	.3	2	W	0321	0541	0761	0981	3169	4169	5169
100	.0028	10	.3	2	W	0322	0542	0762	0982	3170	4170	5170
100	.0034	10	.3	2	W	0323	0543	0763	0983	3171	4171	5171
100	.0034	20	.3	2	W	0324	0544	0764	0984	3172	4172	5172
100	.0041	10	.3	2	W	0325	0545	0765	0985	3173	4173	5173
100	.005	10	.3	2	W	0326	0546	0766	0986	3174	4174	5174
100	.005	20	.3	2	W	0327	0547	0767	0987	3175	4175	5175
100	.006	10	.3	2	W	0328	0548	0768	0988	3176	4176	5176
100	.0075	10	.3	2	W	0329	0549	0769	0989	3177	4177	5177
100	.0075	20	.3	2	W	0330	0550	0770	0990	3178	4178	5178
100	.009	10	.3	2	W	0331	0551	0771	0991	3179	4179	5179
100	.011	10	.3	2	W	0332	0552	0772	0992	3180	4180	5180
100	.011	20	.3	2	W	0333	0553	0773	0993	3181	4181	5181
100	.013	10	.3	2	W	0334	0554	0774	0994	3182	4182	5182
100	.016	10	.3	2	W	0335	0555	0775	0995	3183	4183	5183
100	.016	20	.3	2	W	0336	0556	0776	0996	3184	4184	5184
100	.019	10	.3	2	W	0337	0557	0777	0997	3185	4185	5185
100	.023	10	.3	2	W	0338	0558	0778	0998	3186	4186	5186
100	.023	20	.3	2	W	0339	0559	0779	0999	3187	4187	5187
100	.028	10	.3	2	W	0340	0560	0780	1000	3188	4188	5188
100	.034	10	.3	2	W	0341	0561	0781	1001	3189	4189	5189
100	.034	20	.3	2	W	0342	0562	0782	1002	3190	4190	5190
100	.041	10	.3	2	W	0343	0563	0783	1003	3191	4191	5191
100	.05	10	.3	2	W	0344	0564	0784	1004	3192	4192	5192
100	.05	20	.3	2	W	0345	0565	0785	1005	3193	4193	5193
100	.06	10	.3	2	W	0346	0566	0786	1006	3194	4194	5194
100	.075	10	.3	2	W	0347	0567	0787	1007	3195	4195	5195
100	.075	20	.3	2	W	0348	0568	0788	1008	3196	4196	5196
100	.09	10	.3	2	W	0349	0569	0789	1009	3197	4197	5197
100	.11	10	.3	2	W	0350	0570	0790	1010	3198	4198	5198
100	.11	20	.3	2	W	0351	0571	0791	1011	3199	4199	5199

MIL-C-39003/04
STYLE CSR91
NON-POLAR

Rated voltage	Capacitance (nom)	Capacitance tolerance	DC leakage (max) +25°C	Dissipation factor (max) +25°C	Case size	Dash number — Failure rate level for (%/1,000 hrs) M 1.0	P 0.1	R 0.01	S 0.001	B 0.01	C 0.01	D 0.001
Volts, NP	µF	Percent	µA	Percent								
100	.13	10	.3	2	W	0352	0572	0792	1012	3200	4200	5200
100	.16	10	.3	2	W	0353	0573	0793	1013	3201	4201	5201
100	.16	20	.3	2	W	0354	0574	0794	1014	3202	4202	5202
100	.19	10	.3	2	W	0355	0575	0795	1015	3203	4203	5203
100	.23	10	.3	2	W	0356	0576	0796	1016	3204	4204	5204
100	.23	20	.3	2	W	0357	0577	0797	1017	3205	4205	5205
100	.28	10	.3	2	W	0358	0578	0798	1018	3206	4206	5206
100	.34	10	.3	2	X	0359	0579	0799	1019	3207	4207	5207
100	.34	20	.3	2	X	0360	0580	0800	1020	3208	4208	5208
100	.41	10	.4	2	X	0361	0581	0801	1021	3209	4209	5209
100	.50	10	.5	2	X	0362	0582	0802	1022	3210	4210	5210
100	.50	20	.5	2	X	0363	0583	0803	1023	3211	4211	5211
100	.60	10	.5	4	X	0364	0584	0804	1024	3212	4212	5212
100	.75	10	.7	4	X	0365	0585	0805	1025	3213	4213	5213
100	.75	20	.7	4	X	0366	0586	0806	1026	3214	4214	5214
100	.90	10	.7	4	X	0367	0587	0807	1027	3215	4215	5215
100	1.1	10	.9	4	X	0368	0588	0808	1028	3216	4216	5216
100	1.1	20	.9	4	X	0369	0589	0809	1029	3217	4217	5217
100	1.3	10	1.1	4	X	0370	0590	0810	1030	3218	4218	5218

MIL-C-3965

Military Style Tantalum Capacitors

CL20 CL21

MIL-C-3965 Part Number System

Example: CL31 B J 200 M P G

Style	Description
CL20	Polar, etch foil, uninsulated
CL21	Polar, etch foil, insulated
CL22	Non polar, etch foil, uninsulated
CL23	Non polar, etch foil, insulated
CL30	Polar, plain foil, uninsulated
CL31	Polar, plain foil, insulated
CL32	Non polar, plain foil, uninsulated
CL33	Non polar, plain foil, insulated
CL70	Polar, high-etch foil, uninsulated
CL71	Polar, high-etch foil, insulated
CL72	Non polar, high-etch foil, uninsulated
CL73	Non polar, high-etch foil, insulated

Characteristic
–55°C to 85°C (Will operate up to 125°C when properly derated)

Capacitance—Expressed in (uf)
First two digits represent significant figures; third digit represents number of zeros to follow. "R" indicates decimal point.

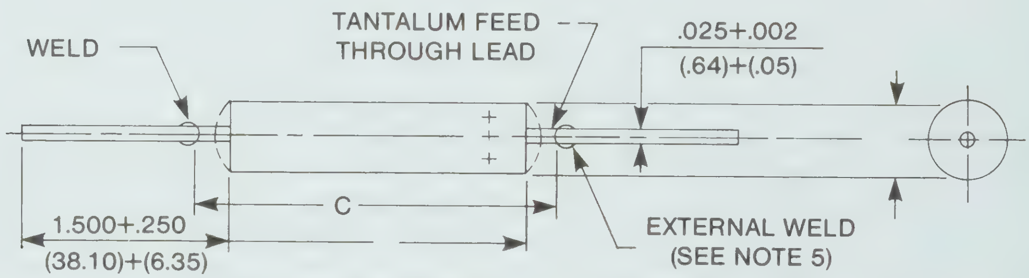
Seal
G—Hermetic (Glass)
E—Non hermetic (Elastomer)

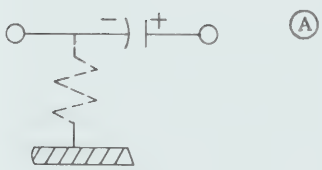
Construction
P—Polar
N—Non polar

Voltage Symbol	Volts 85°C/125°C	Voltage Symbol	Volts 85°C/125°C
A	3/2	N	100/65
B	6/4	O	250/165
C	8/5	P	125/85
D	10/7	Q	150/100
E	15/10	R	180/120
F	20/13	S	270/180
G	25/15	T	360/240
H	30/20	U	450/300
I	112/75	V	540/360
J	50/30	W	630/420
K	60/40	X	300/200
L	75/50	Y	375/250
M	90/60	Z	200/150

Capacitance Symbol	Tolerance %
J	±5
K	±10
L	±15
M	±20
S	+30-15
T	+50-15
U	+75-15

Outline Drawing and Dimensions
Styles CL20-23, CL30-33, and CL70-73





CIRCUIT DIAGRAM
(SEE NOTE 4)

Case size	Dimensions			
	Basic case		Insulated case	
	L* ±.062 (1.57)	D ±.016 (.41)	D Max	C Max
E1	.688 (17.48)	.188 (4.78)	.219 (5.56)	1.188 (30.18)
E2	.906 (23.01)	.281 (7.14)	.312 (7.92)	1.406 (35.71)
G2	.969 (24.61)	.281 (7.14)	.312 (7.92)	1.469 (37.31)
E3, G3	1.438 (36.53)	.375 (9.53)	.406 (10.31)	1.938 (49.23)
E4, G4	2.125 (53.98)	.375 (9.53)	.406 (10.31)	2.625 (66.68)
E5, G5	2.750 (69.85)	.375 (9.53)	.406 (10.31)	3.250 (82.55)

**For insulated styles shrinkable sleeving shall lap over the ends of the case.*

NOTES:
1. Dimensions are in inches.
2. Millimeters are in parentheses.
3. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.
4. There is an indeterminate resistance between the metal case and the negative terminal.
5. The weld shall not be enclosed in the end seal.

MIL-C-3965/17
STYLES CL20 & CL21

Type designation 1/	Voltage Rated (85°C)	Voltage Derated (125°C)	Voltage Surge (85°C)	Capacitance	DC leakage (max) 25°C	DC leakage (max) 85°C & 125°C	Impedance (max)	Case size 2/
	volts, dc	volts, dc	volts, dc	uF	uA	uA	ohms	
CL2-BE150UPE	15	10	17.2	15	2	4	220	E1
CL2-BE600UP-	15	10	17.2	60	2	10	55	E2
CL2-BE201UP-	15	10	17.2	200	3	40	17	E3
CL2-BE401UP-	15	10	17.2	400	6	80	9	E4
CL2-BE581UP-	15	10	17.2	580	9	100	6	E5
CL2-BG100UPE	25	15	28.8	10	2	4	330	E1
CL2-BG400UP-	25	15	28.8	40	2	13	83	E2
CL2-BG121UP-	25	15	28.8	120	3	40	27	E3
CL2-BG251UP-	25	15	28.8	250	6	80	13	E4
CL2-BG351UP-	25	15	28.8	350	10	100	10	E5
CL2-BH080UPE	30	20	34.5	8	2	6	424	E1
CL2-BH320UP-	30	20	34.5	32	2	14	106	E2
CL2-BH111UP-	30	20	34.5	110	4	50	31	E3
CL2-BH221UP-	30	20	34.5	220	8	90	16	E4
CL2-BH301UP-	30	20	34.5	300	11	120	11	E5
CL2-BJ4R5TPE	50	30	57.5	4.5	2	4	730	E1
CL2-BJ180TP-	50	30	57.5	18	2	13	180	E2
CL2-BJ600TP-	50	30	57.5	60	3	40	55	E3
CL2-BJ101TP-	50	30	57.5	100	4	75	33	E4
CL2-BJ151TP-	50	30	57.5	150	5	100	22	E5
CL2-BL030TPE	75	50	86.2	3	2	4	1000	E1
CL2-BL120TP-	75	50	86.2	12	2	13	270	E2
CL2-BL300TP-	75	50	86.2	30	3	34	110	E3
CL2-BL700TP-	75	50	86.2	70	6	80	47	E4
CL2-BL101TP-	75	50	86.2	100	10	100	33	E5
CL2-BN020SPE	100	65	115.0	2	2	4	1600	E1
CL2-BN080SP-	100	65	115.0	8	2	12	410	E2
CL2-BN250SP-	100	65	115.0	25	2.5	37	130	E3
CL2-BN500SP-	100	65	115.0	50	5	75	66	E4
CL2-BN700SP-	100	65	115.0	70	7	100	47	E5
CL2-BQ010SPE	150	100	172.0	1	2	4	3000	E1
CL2-BQ040SP-	150	100	172.0	4	2	13	750	E2
CL2-BQ130SP-	150	100	172.0	13	3	30	250	E3
CL2-BQ250SP-	150	100	172.0	25	5	80	130	E4
CL2-BQ360SP-	150	100	172.0	36	8	100	94	E5

1/ Complete type designation will include an additional symbol to indicate style, and where applicable, an additional symbol to indicate type of seal.
2/ Where applicable, the complete case size will include an additional symbol to indicate type of seal.

MIL-C-3965/18
STYLES CL22 & CL23

Type designation 1/	Voltage Rated (85°C)	Voltage Derated (125°C)	Voltage Surge (85°C)	Capacitance	DC leakage (max) 25°C	DC leakage (max) 85°C & 125°C	Impedance (max)	Case size 2/
	volts, dc	volts, dc	volts, dc	uF	uA	uA	ohms	
CL2-BE100UNE	15	10	17.2	10	2	4	339	E1
CL2-BE400UN-	15	10	17.2	40	2	10	85	E2
CL2-BE121UN-	15	10	17.2	120	3	40	27	E3
CL2-BE251UN-	15	10	17.2	250	6	80	14	E4
CL2-BE351UN-	15	10	17.2	350	9	100	10	E5
CL2-BG050UNE	25	15	28.8	5	2	4	680	E1
CL2-BG200UN-	25	15	28.8	20	2	13	170	E2
CL2-BG700UN-	25	15	28.8	70	3	40	49	E3
CL2-BG141UN-	25	15	28.8	140	6	80	24	E4
CL2-BG201UN-	25	15	28.8	200	10	100	17	E5
CL2-BH4R5UNE	30	20	34.5	4.5	2	6	754	E1
CL2-BH180UN-	30	20	34.5	18	2	14	188	E2
CL2-BH600UN-	30	20	34.5	60	4	50	57	E3
CL2-BH121UN-	30	20	34.5	120	8	90	28	E4
CL2-BH171UN-	30	20	34.5	170	11	120	20	E5
CL2-BJ2R5TNE	50	30	57.5	2.5	2	4	1355	E1
CL2-BJ100TN-	50	30	57.5	10	2	13	339	E2
CL2-BJ300TN-	50	30	57.5	30	3	40	113	E3
CL2-BJ600TN-	50	30	57.5	60	4	75	57	E4
CL2-BJ800TN-	50	30	57.5	80	5	100	41	E5
CL2-BL1R5TNE	75	50	86.2	1.5	2	4	2255	E1
CL2-BL060TN-	75	50	86.2	6	2	13	560	E2
CL2-BL150TN-	75	50	86.2	15	3	34	226	E3
CL2-BL350TN-	75	50	86.2	35	5	80	97	E4
CL2-BL500TN-	75	50	86.2	50	10	100	68	E5
CL2-BN010TNE	100	65	115.0	1	2	4	3385	E1
CL2-BN040TN-	100	65	115.0	4	2	13	845	E2
CL2-BN120TN-	100	65	115.0	12	3	37	283	E3
CL2-BN250TN-	100	65	115.0	25	5	75	135	E4
CL2-BN350TN-	100	65	115.0	35	7	100	97	E5
CL2-BQ0R5SNE	150	100	172.0	0.5	2	4	6780	E1
CL2-BQ020SN-	150	100	172.0	2	2	13	1693	E2
CL2-BQ060SN-	150	100	172.0	6	3	30	565	E3
CL2-BQ120SN-	150	100	172.0	12	5	80	283	E4
CL2-BQ180SN-	150	100	172.0	18	8	100	188	E5

1/ Complete type designation will include an additional symbol to indicate style, and where applicable, an additional symbol to indicate type of seal.
2/ Where applicable, the complete case size will include an additional symbol to indicate type of seal.

MIL-C-3965/15
STYLES CL30 & CL31

Type designation 1/	Rated (85°C)	Voltage Derated (125°C)	Surge (85°C)	Capacitance	DC leakage (max) 25°C	DC leakage (max) 85°C & 125°C	Impedance (max)	Case size 2/
	volts, dc	volts, dc	volts, dc	uF	uA	uA	ohms	
CL3-BA100MPE	3	2	3.4	10	1	2	250	E1
CL3-BA500MP-	3	2	3.4	50	2	6	50	E2
CL3-BB080MPE	6	4	6.9	8	1	2	329	E1
CL3-BB300MP-	6	4	6.9	30	2	6	88	E2
CL3-BB101MP-	6	4	6.9	100	2	10	26	E3
CL3-BB201MP-	6	4	6.9	200	4	30	13	E4
CL3-BB301MP-	6	4	6.9	300	5	50	9	E5
CL3-BD060MPE	10	7	11.5	6	1	2	440	E1
CL3-BD250MP-	10	7	11.5	25	2	6	105	E2
CL3-BD800MP-	10	7	11.5	80	2	10	33	E3
CL3-BD161MP-	10	7	11.5	160	4	20	17	E4
CL3-BD221MP-	10	7	11.5	220	5	50	12	E5
CL3-BE4R5MPE	15	10	17.2	4.5	1	2	495	E1
CL3-BE100MP-	15	10	17.2	10	2	4	250	E2
CL3-BE180MP-	15	10	17.2	18	2	4	125	E2
CL3-BE550MP-	15	10	17.2	55	2	10	41	E3
CL3-BE111MP-	15	10	17.2	110	4	20	20	E4
CL3-BE161MP-	15	10	17.2	160	5	30	14	E5
CL3-BG030MPE	25	15	28.8	3	1	2	744	E1
CL3-BG120MP-	25	15	28.8	12	2	4	186	E2
CL3-BG350MP-	25	15	28.8	35	2	10	64	E3
CL3-BG700MP-	25	15	28.8	70	4	20	32	E4
CL3-BG101MP-	25	15	28.8	100	6	30	23	E5
CL3-BH2R5MPE	30	20	34.5	2.5	2	5	893	E1
CL3-BH100MP-	30	20	34.5	10	2	6	265	E2
CL3-BH300MP-	30	20	34.5	30	2	13	75	E3
CL3-BH600MP-	30	20	34.5	60	4	26	37	E4
CL3-BH850MP-	30	20	34.5	85	6	38	27	E5
CL3-BJ1R5MPE	50	30	57.5	1.5	1	4	1487	E1
CL3-BJ060MP-	50	30	57.5	6	2	6	372	E2
CL3-BJ200MP-	50	30	57.5	20	2	13	112	E3
CL3-BJ400MP-	50	30	57.5	40	4	26	56	E4
CL3-BJ550MP-	50	30	57.5	55	6	38	41	E5
CL3-BL010MPE	75	50	86.2	1	1	4	2232	E1
CL3-BL040MP-	75	50	86.2	4	2	6	558	E2
CL3-BL140MP-	75	50	86.2	14	2	13	159	E3
CL3-BL280MP-	75	50	86.2	28	4	26	80	E4
CL3-BL400MP-	75	50	86.2	40	6	38	56	E5
CL3-BN0R8MPE	100	65	115.0	0.8	1	3.5	2790	E1
CL3-BN030MP-	100	65	115.0	3	2	6	743	E2
CL3-BN100MP-	100	65	115.0	10	2	13	223	E3
CL3-BN200MP-	100	65	115.0	20	3	25	112	E4
CL3-BN300MP-	100	65	115.0	30	6	38	74	E5
CL3-BQ0R5MPE	150	100	172.0	0.5	2	4	4454	E1
CL3-BQ020MP-	150	100	172.0	2	2	6	1115	E2
CL3-BQ040MP-	150	100	172.0	4	3	13	558	E3
CL3-BQ070MP-	150	100	172.0	7	3	13	319	E3
CL3-BQ080MP-	150	100	172.0	8	4	26	265	E4
CL3-BQ120MP-	150	100	172.0	12	4	26	208	E4
CL3-BQ140MP-	150	100	172.0	14	4	26	159	E4
CL3-BQ200MP-	150	100	172.0	20	6	38	112	E5
CL3-BZR35LPE	200	150	230.0	0.35	4	25	5577	E1
CL3-BZ1R5LP-	200	150	230.0	1.5	8	32	1300	E2
CL3-BZ050LP-	200	150	230.0	5	16	64	400	E3
CL3-BZ100LP-	200	150	230.0	10	28	100	200	E4
CL3-BZ150LP-	200	150	230.0	15	40	160	130	E5
CL3-BOR30LPE	250	165	287.0	.30	6	32	6600	E1
CL3-BO1R2LP-	250	165	287.0	1.2	8	40	1600	E2
CL3-BO040LP-	250	165	287.0	4	16	80	500	E3
CL3-BO080LP-	250	165	287.0	8	28	140	250	E4
CL3-BO120LP-	250	165	287.0	12	40	200	160	E5
CL3-BXR27LPE	300	200	345.0	.27	6	40	9000	E1
CL3-BX010LP-	300	200	345.0	1	10	50	2250	E2
CL3-BX030LP-	300	200	345.0	3	20	100	750	E3
CL3-BX070LP-	300	200	345.0	7	35	175	322	E4
CL3-BX100LP-	300	200	345.0	10	50	250	225	E5

1/ Complete type designation will include an additional symbol to indicate style, and where applicable, an additional symbol to indicate type of seal.
2/ Where applicable, the complete case size will include an additional symbol to indicate type of seal.

MIL-C-3965

Military Style Tantalum Capacitors

MIL-C-3965/16
STYLES CL32 & CL33

Type designation 1/	Rated (85°C)	Voltage Derated (125°C)	Surge (85°C)	Capacitance	DC leakage (max) 25°C	DC leakage (max) 85°C & 125°C	Impedance (max)	Case size 2/
	volts, dc	volts, dc	volts, dc	uF	uA	uA	ohms	
CL3-BA100MNE	3	2	3.4	10	1	2	263	E1
CL3-BA450-MN-	3	2	3.4	45	2	4	59	E2
CL3-BA141MN-	3	2	3.4	140	2	10	19	E3
CL3-BA281MN-	3	2	3.4	280	3	20	10	E4
CL3-BA401MN-	3	2	3.4	400	5	30	6	E5
CL3-BB070MNE	6	4	6.9	7	1	2	377	E1
CL3-BB250MN-	6	4	6.9	25	2	4	105	E2
CL3-BB850MN-	6	4	6.9	85	2	10	31	E3
CL3-BB171MN-	6	4	6.9	170	4	20	15	E4
CL3-BB251MN-	6	4	6.9	250	5	30	11	E5
CL3-BD040MNE	10	7	11.5	4	1	2	660	E1
CL3-BD160MN-	10	7	11.5	16	2	4	165	E2
CL3-BD550MN-	10	7	11.5	55	2	10	48	E3
CL3-BD111MN-	10	7	11.5	110	4	20	24	E4
CL3-BD151MN-	10	7	11.5	150	5	30	18	E5
CL3-BE2R5MNE	15	10	17.2	2.5	1	2	893	E1
CL3-BE100MN-	15	10	17.2	10	2	4	223	E2
CL3-BE350MN-	15	10	17.2	35	2	10	64	E3
CL3-BE700MN-	15	10	17.2	70	4	20	32	E4
CL3-BE101MN-	15	10	17.2	100	5	30	23	E5
CL3-BG1R5MNE	25	15	28.8	1.5	1	3	1487	E1
CL3-BG060MN-	25	15	28.8	6	2	6	372	E2
CL3-BG200MN-	25	15	28.8	20	2	10	112	E3
CL3-BG400MN-	25	15	28.8	40	4	20	56	E4
CL3-BG600MN-	25	15	28.8	60	5	30	37	E5
CL3-BH1R4MNE	30	20	34.5	1.4	2	5	1594	E1
CL3-BH5R5MN-	30	20	34.5	5.5	2	6	406	E2
CL3-BH180MN-	30	20	34.5	18	2	12	124	E3
CL3-BH360MN-	30	20	34.5	36	4	26	62	E4
CL3-BH450MN-	30	20	34.5	45	6	36	50	E5
CL3-BJ0R8MNE	50	30	57.5	0.8	1	4	2790	E1
CL3-BJ030MN-	50	30	57.5	3	2	6	743	E2
CL3-BJ100MN-	50	30	57.5	10	2	12	223	E3
CL3-BJ200MN-	50	30	57.5	20	4	24	112	E4
CL3-BJ300MN-	50	30	57.5	30	6	36	75	E5
CL3-BL0R5MNE	75	50	86.2	0.5	1	4	4460	E1
CL3-BL020MN-	75	50	86.2	2	2	6	1115	E2
CL3-BL070MN-	75	50	86.2	7	2	13	319	E3
CL3-BL140MN-	75	50	86.2	14	4	24	159	E4
CL3-BL200MN-	75	50	86.2	20	6	36	112	E5
CL3-BN0R4MNE	100	65	115.0	0.4	1	3.5	5580	E1
CL3-BN1R5MN-	100	65	115.0	1.5	2	6	1487	E2
CL3-BN050MN-	100	65	115.0	5	2	13	446	E3
CL3-BN100MN-	100	65	115.0	10	4	24	223	E4
CL3-BN150MN-	100	65	115.0	15	6	36	149	E5
CL3-BQR25MNE	150	100	172.0	0.25	2	4	8908	E1
CL3-BQ010MN-	150	100	172.0	1	2	6	2227	E2
CL3-BQ3R5MN-	150	100	172.0	3.5	3	13	638	E3
CL3-BQ070MN-	150	100	172.0	7	4	24	319	E4
CL3-BQ100MN-	150	100	172.0	10	6	36	223	E5
CL3-BZR15LNE	200	150	259.0	0.15	4	25	14000	E1
CL3-BZR75LN-	200	150	259.0	0.75	8	32	2600	E2
CL3-BZ2R5LN-	200	150	259.0	2.5	16	64	800	E3
CL3-BZ050LN-	200	150	259.0	5	28	112	400	E4
CL3-BZ7R5LN-	200	150	259.0	7.5	40	160	260	E5
CL3-BOR15LNE	250	165	287.0	0.15	6	32	13000	E1
CL3-BO0R6LN-	250	165	287.0	0.6	8	40	3300	E2
CL3-BO020LN-	250	165	287.0	2	16	80	1000	E3
CL3-BO040LN-	250	165	287.0	4	28	140	500	E4
CL3-BO060LN-	250	165	287.0	6	40	200	330	E5
CL3-BXR12LNE	300	200	345.0	0.12	4	25	17500	E1
CL3-BXR47LN-	300	200	345.0	0.47	10	50	4500	E2
CL3-BX1R5LN-	300	200	345.0	1.5	20	100	1500	E3
CL3-BX3R3LN-	300	200	345.0	3.3	35	175	643	E4
CL3-BX4R7LN-	300	200	345.0	4.7	50	250	450	E5

1/ Complete type designation will include an additional symbol to indicate style, and where applicable, an additional symbol to indicate type of seal.
2/ Where applicable, the complete case size will include an additional symbol to indicate type of seal.

MIL-C-3965/22
STYLES CL70 & CL71

Type designation 1/	Voltage Rated (85°C)	Voltage Derated (125°C)	Voltage Surge (85°C)	Capacitance	DC leakage (max) 25°C	DC leakage (max) 85°C	DC leakage (max) 125°C	Impedance (max)	Case size
	volts, dc	volts, dc	volts, dc	uF	uA	uA	uA	ohms	
CL7-BE290UPE	15	10	17.2	29	7	35	23	137	E1
CL7-BE101UPE	15	10	17.2	100	23	100	80	37	E2
CL7-BE311UPE	15	10	17.2	310	61	370	250	10.8	E3
CL7-BE651UPE	15	10	17.2	650	130	780	520	5.1	E4
CL7-BE921UPE	15	10	17.2	920	185	1100	750	4.0	E5
CL7-BG170UPE	25	15	28.8	17	6	34	21	220	E1
CL7-BG600UPE	25	15	28.8	60	23	100	72	62	E2
CL7-BG181UPE	25	15	28.8	180	60	360	220	20.5	E3
CL7-BG381UPE	25	15	28.8	380	125	760	460	9.6	E4
CL7-BG551UPE	25	15	28.8	550	185	1100	660	6.7	E5
CL7-BH150UPE	30	20	34.5	15	6	34	22	250	E1
CL7-BH520UPE	30	20	34.5	52	23	120	80	71	E2
CL7-BH151UPE	30	20	34.5	150	60	360	240	25	E3
CL7-BH321UPE	30	20	34.5	320	125	750	500	11.5	E4
CL7-BH461UPE	30	20	34.5	460	165	1000	700	8	E5
CL7-BJ070TPE	50	30	57.5	7	5	28	17	550	E1
CL7-BJ250TPE	50	30	57.5	25	19	100	60	150	E2
CL7-BJ750TPE	50	30	57.5	75	50	300	180	49	E3
CL7-BJ161TPE	50	30	57.5	160	100	640	390	23	E4
CL7-BJ231TPE	50	30	57.5	230	150	920	550	16	E5
CL7-BL040TPE	75	50	86.2	4	5	24	16	930	E1
CL7-BL150TPE	75	50	86.2	15	17	90	60	250	E2
CL7-BL450TPE	75	50	86.2	45	45	270	180	83	E3
CL7-BL950TPE	75	50	86.2	95	95	570	380	39	E4
CL7-BL131TPE	75	50	86.2	130	130	780	520	29	E5
CL7-BN030SPE	100	65	115.0	3	4	20	14	1210	E1
CL7-BN100SPE	100	65	115.0	10	15	80	52	370	E2
CL7-BN300SPE	100	65	115.0	30	40	230	150	121	E3
CL7-BN630SPE	100	65	115.0	63	80	480	310	58	E4
CL7-BN900SPE	100	65	115.0	90	120	720	470	41	E5
CL7-BQ1R6SPE	150	100	172.0	1.6	3	18	12	2340	E1
CL7-BQ5R5SPE	150	100	172.0	5.5	12	64	42	675	E2
CL7-BQ170SPE	150	100	172.0	17	30	190	130	220	E3
CL7-BQ350SPE	150	100	172.0	35	65	400	260	106	E4
CL7-BQ500SPE	150	100	172.0	50	95	560	380	74	E5

1/ Complete type designation will include an additional symbol to indicate style.

MIL-C-3965

Military Style Tantalum Capacitors

MIL-C-3965/23
STYLES CL72 & CL73

Type designation 1/	Voltage Rated (85°C)	Voltage Derated (125°C)	Voltage Surge (85°C)	Capacitance	DC leakage (max) 25°C	DC leakage (max) 85°C	DC leakage (max) 125°C	Impedance (max)	Case size
	volts, dc	volts, dc	volts, dc	uF	uA	uA	uA	ohms	
CL7-BE200UNE	15	10	17.2	20	5	24	16	185	E1
CL7-BE700UNE	15	10	17.2	70	15	84	56	55	E2
CL7-BE201UNE	15	10	17.2	200	40	240	160	18.5	E3
CL7-BE411UNE	15	10	17.2	410	75	500	330	8.9	E4
CL7-BE591UNE	15	10	17.2	590	118	710	470	6.2	E5
CL7-BG100UNE	25	15	28.8	10	4	20	12	370	E1
CL7-BG350UNE	25	15	28.8	35	12	70	43	106	E2
CL7-BG101UNE	25	15	28.8	100	30	200	120	37	E3
CL7-BG211UNE	25	15	28.8	210	40	400	250	17.5	E4
CL7-BG301UNE	25	15	28.8	300	100	600	360	12.1	E5
CL7-BH080UNE	30	20	34.5	8	3	19	12	455	E1
CL7-BH290UNE	30	20	34.5	29	11	60	40	137	E2
CL7-BH800UNE	30	20	34.5	80	30	180	120	45.5	E3
CL7-BH171UNE	30	20	34.5	170	65	390	260	22	E4
CL7-BH241UNE	30	20	34.5	240	90	550	370	7.8	E5
CL7-BJ3R5TNE	50	30	57.5	3.5	3	14	9	1060	E1
CL7-BJ130TNE	50	30	57.5	13	10	52	31	285	E2
CL7-BJ360TNE	50	30	57.5	36	24	145	86	104	E3
CL7-BJ750TNE	50	30	57.5	75	45	300	180	49	E4
CL7-BJ111TNE	50	30	57.5	110	75	440	260	34	E5
CL7-BL020TNE	75	50	86.2	2	2	12	8	1850	E1
CL7-BL070TNE	75	50	86.2	7	8	42	28	550	E2
CL7-BL200TNE	75	50	86.2	20	23	120	80	185	E3
CL7-BL430TNE	75	50	86.2	43	45	260	170	86	E4
CL7-BL600TNE	75	50	86.2	60	60	360	240	62	E5
CL7-BN1R4SNE	100	65	115.0	1.4	2	11	7	2700	E1
CL7-BN050SNE	100	65	115.0	5	7	38	25	750	E2
CL7-BN140SNE	100	65	115.0	14	15	110	68	268	E3
CL7-BN290SNE	100	65	115.0	29	35	220	145	137	E4
CL7-BN410SNE	100	65	115.0	41	50	320	210	91	E5
CL7-BQR75SNE	150	100	172.0	0.75	2	9	6	5000	E1
CL7-BQ2R7SNE	150	100	172.0	2.7	6	30	20	1380	E2
CL7-BQ7R5SNE	150	100	172.0	7.5	15	84	56	490	E3
CL7-BQ150SNE	150	100	172.0	15	30	180	120	250	E4
CL7-BQ220SNE	150	100	172.0	22	45	270	175	170	E5

1/ Complete type designation will include an additional symbol to indicate style.

MIL-C-3965 Part Number System

Example: CL51 B J 200 M P G

Style	Description
CL51	Polar, plain foil, KSR™
CL52	Non polar, plain foil, KSR™
CL53	Polar, etch foil, KSR™
CL54	Non polar, etch foil, KSR™

Characteristic
55°C to 85°C
(Will operate up to 125°C when properly derated)

Capacitance—Expressed in (uf)
First two digits represent significant figures; third digit represents number of zeros to follow. "R" indicates decimal point.

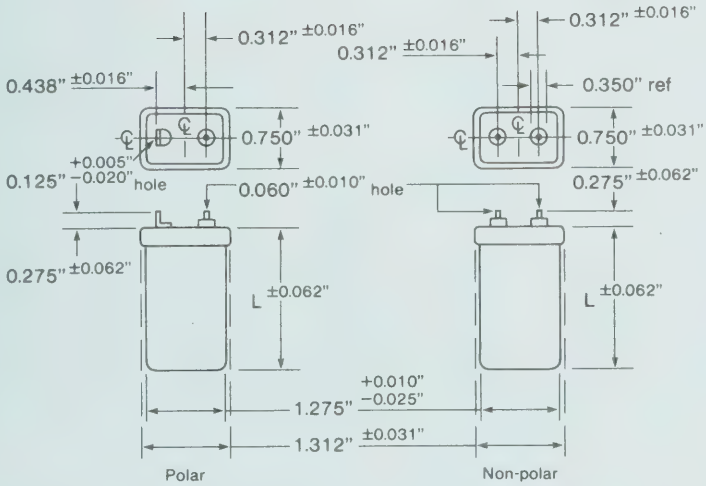
Seal
G—Hermetic (Glass)

Construction
P—Polar
N—Non polar

Voltage Symbol	Volts 85°C/125°C	Voltage Symbol	Volts 85°C/125°C
A	3/2	N	100/65
B	6/4	O	250/165
C	8/5	P	125/85
D	10/7	Q	150/100
E	15/10	R	180/120
F	20/13	S	270/180
G	25/15	T	360/240
H	30/20	U	450/300
I	112/75	V	540/360
J	50/30	W	630/420
K	60/40	X	300/200
L	75/50	Y	375/250
M	90/60	Z	200/150

Capacitance Symbol	Tolerance %
J	±5
K	±10
L	±15
M	±20
S	+30-15
T	+50-15
U	+75-15

Outline Drawing and Dimensions
Styles CL51-54



Dimensions
L ±.062 (1.57)

	In	mm
D1	1.375	34.93
D2	2.000	50.80
D3	2.500	63.50

INCHES	MM	INCHES	MM	INCHES	MM
.010	.25	.070	1.78	.395	10.03
.016	.41	.156	3.96	.703	17.86
.025	.64	.275	6.99	.750	19.05
.031	.79	.312	7.92	.783	19.89
.060	1.52	.350	8.89	1.275	32.39
.062	1.57	.364	9.25	1.378	35.00
		.374	9.50		

NOTES
1 All dimensions in inches
2 Metric equivalents (to the nearest 01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.
3 Orientation of terminal hole not fixed

MIL-C-3965

Military Style Tantalum Capacitors

MIL-C-3965/9
STYLE CL51

Type designation	Rated (85°C)	Voltage Derated (125°C)	Surge (85°C)	Capacitance	DC leakage (max) 25°C	DC leakage (max) 85°C	DC leakage (max) 125°C	Impedance (max)	Case size
	volts, dc	volts, dc	volts, dc	uF	uA	uA	uA	ohms	
CL51BE331MPG	15	10	17.2	330	23	185	230	8.5	D1
CL51BE661MPG	15	10	17.2	660	46	370	460	4.2	D2
CL51BE961MPG	15	10	17.2	960	67	535	670	2.9	D3
CL51BH181MPG	30	20	34.5	180	25	200	250	15.5	D1
CL51BH361MPG	30	20	34.5	360	50	400	500	7.8	D2
CL51BH511MPG	30	20	34.5	510	71	570	710	5.5	D3
CL51BJ121MPG	50	30	57.5	120	26	210	260	22.5	D1
CL51BJ251MPG	50	30	57.5	250	52	415	520	11.0	D2
CL51BJ351MPG	50	30	57.5	350	73	585	730	8.0	D3
CL51BL750MPG	75	50	86.2	75	26	210	260	37.0	D1
CL51BL151MPG	75	50	86.2	150	52	415	520	18.5	D2
CL51BL221MPG	75	50	86.2	220	77	615	770	12.5	D3
CL51BI500MPG	112	75	129.0	50	26	210	260	55.5	D1
CL51BI101MPG	112	75	129.0	100	52	415	520	29.5	D2
CL51BI151MPG	112	75	129.0	150	78	625	780	18.5	D3
CL51BQ400MPG	150	100	172.0	40	28	225	280	70.0	D1
CL51BQ800MPG	150	100	172.0	80	56	450	560	35.0	D2
CL51BQ101MPG	150	100	172.0	100	70	560	700	30.0	D3

MIL-C-3965/10
STYLE CL52

Type designation	Rated (85°C)	Voltage Derated (125°C)	Surge (85°C)	Capacitance	DC leakage (max) 25°C	DC leakage (max) 85°C	DC leakage (max) 125°C	Impedance (max)	Case size
	volts, dc	volts, dc	volts, dc	uF	uA	uA	uA	ohms	
CL52BE211MNG	15	10	17.2	210	21	170	210	13.2	D1
CL52BE421MNG	15	10	17.2	420	42	335	420	6.6	D2
CL52BE601MNG	15	10	17.2	600	60	480	600	4.6	D3
CL52BH780MNG	30	20	34.5	78	15	120	150	35.6	D1
CL52BH151MNG	30	20	34.5	150	30	240	300	18.5	D2
CL52BH271MNG	30	20	34.5	270	54	430	540	10.3	D3
CL52BJ650MNG	50	30	57.5	65	19	150	190	42.7	D1
CL52BJ131MNG	50	30	57.5	130	39	310	390	21.4	D2
CL52BJ171MNG	50	30	57.5	170	51	410	510	16.3	D3
CL52BL380MNG	75	50	86.2	38	19	150	190	73.2	D1
CL52BL750MNG	75	50	86.2	75	37	295	370	37.1	D2
CL52BL111MNG	75	50	86.2	110	55	440	550	25.2	D3
CL52BI250MNG	112	75	129.0	25	18	145	180	111	D1
CL52BI500MNG	112	75	129.0	50	37	295	370	55.6	D2
CL52BI750MNG	112	75	129.0	75	56	450	560	37.1	D3
CL52BQ200MNG	150	100	172.0	20	20	160	200	139	D1
CL52BQ400MNG	150	100	172.0	40	40	320	400	69.5	D2
CL52BQ500MNG	150	100	172.0	50	50	400	500	55.6	D3

MIL-C-3965

Military Style Tantalum Capacitors

MIL-C-3965/11
STYLE CL53

Type designation	Rated (85°C)	Voltage Derated (125°C)	Surge (85°C)	Capacitance	DC leakage (max) 25°C	DC leakage (max) 85°C	DC leakage (max) 125°C	Impedance (max)	Case size
	volts, dc	volts, dc	volts, dc	uF	uA	uA	uA	ohms	
CL53BE122UPG	15	10	17.2	1,200	42	335	420	7	D1
CL53BE242UPG	15	10	17.2	2,400	84	670	840	4	D2
CL53BE352UPG	15	10	17.2	3,500	122	975	1,220	2	D3
CL53BH661UPG	30	20	34.5	660	46	370	460	13	D1
CL53BH132UPG	30	20	34.5	1,300	75	600	750	6	D2
CL53BH182UPG	30	20	34.5	1,800	92	735	920	5	D3
CL53BJ351UPG	50	30	57.5	350	36	290	360	11.5	D1
CL53BJ701UPG	50	30	57.5	700	73	585	730	5 7	D2
CL53BJ102UPG	50	30	57.5	1,000	105	840	1,050	4.0	D3
CL53BL201UPG	75	50	86.2	200	35	280	350	20	D1
CL53BL401UPG	75	50	86.2	400	70	560	700	10	D2
CL53BL551UPG	75	50	86.2	550	96	770	960	7.2	D3
CL53BI121UPG	112	75	129.0	120	31	250	310	86	D1
CL53BI241UPG	112	75	129.0	240	63	505	630	16.5	D2
CL53BI321UPG	112	75	129.0	320	84	670	840	12.5	D3
CL53BQ700UPG	150	100	172.0	70	24	190	240	57	D1
CL53BQ141UPG	150	100	172.0	140	49	390	490	29	D2
CL53BQ201UPG	150	100	172.0	200	70	560	700	20	D3

MIL-C-3965/12
STYLE CL54

Type designation	Rated (85°C)	Voltage Derated (125°C)	Surge (85°C)	Capacitance	DC leakage (max) 25°C	DC leakage (max) 85°C	DC leakage (max) 125°C	Impedance (max)	Case size
	volts, dc	volts, dc	volts, dc	uF	uA	uA	uA	ohms	
CL54BE751UNG	15	10	17.2	750	52	400	500	11	D1
CL54BE152UNG	15	10	17.2	1,500	105	840	1,050	6	D2
CL54BE212UNG	15	10	17.2	2,100	147	1,175	1,470	4	D3
CL54BH361UNG	30	20	34.5	360	50	400	500	24	D1
CL54BH721UNG	30	20	34.5	720	100	800	1,000	12	D2
CL54BH102UNG	30	20	34.5	1,000	140	1,120	1,400	8	D3
CL54BJ201UNG	50	30	57.5	200	42	335	420	20	D1
CL54BJ401UNG	50	30	57.5	400	84	670	840	10	D2
CL54BJ551UNG	50	30	57.5	550	115	920	1,150	7.2	D3
CL54BL101UNG	75	50	86.2	100	35	280	350	40	D1
CL54BL201UNG	75	50	86.2	200	70	560	700	20	D2
CL54BL271UNG	75	50	86.2	270	94	750	940	15	D3
CL54BI600UNG	112	75	129.0	60	31	250	310	66	D1
CL54BI121UNG	112	75	129.0	120	63	505	630	33	D2
CL54BI161UNG	112	75	129.0	160	84	670	840	25	D3
CL54BQ350UNG	150	100	172.0	35	24	190	240	115	D1
CL54BQ700UNG	150	100	172.0	70	49	390	490	57	D2
CL54BQ101UNG	150	100	172 0	100	70	560	700	40	D3

MIL-C-3965

Military Style Tantalum Capacitors

CL53 CL54

BRACKET INFORMATION

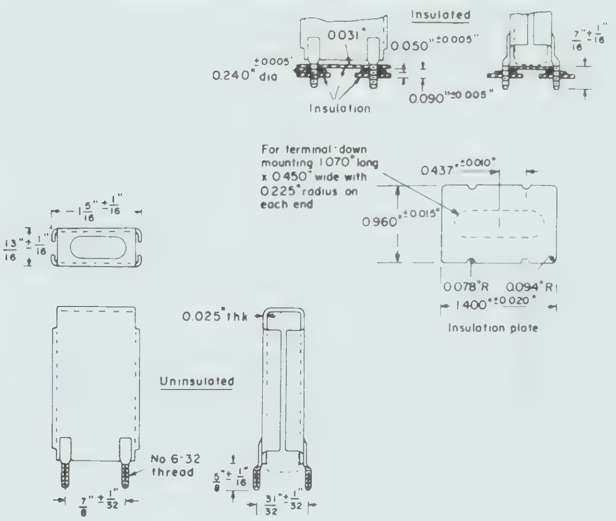
STAINLESS-STEEL MOUNTING BRACKETS

Case Size*	Case Height In Inches	Insulated Terminal Up	Bracket Identification Insulated Terminal Down	Bracket Identification Uninsulated	MIL No. † Uninsulated
10	2.5	942A797P48	942A797P58	942A798P45	CL050SD33
20	2.0	942A797P47	942A797P57	942A798P44	CL050SD23
30	1.375	942A797P46	942A797P56	942A798P42	CL050SD13

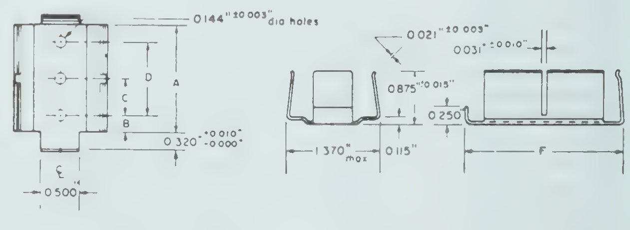
*Common base dimension — 1.312 by 0.750 inches.

† For MIL marked parts. Order by MIL number.

These KSR™ capacitor brackets meet vibration and shock requirements of MIL-STD-202A, Method 204B.



Non-MIL Spring-clip Type



TOL.	±.010	±.005	±.005	±.005	—	Max	Case Size	Finish
Pt. No.	A	B	C	D	E	F		
21	1.000	0.250	0.500	—	2	1.500	30	Cadmium plate and gold iridite
22	1.625	.250	.562	1.125	3	2.125	20	
23	2.125	.312	.750	1.500	3	2.625	10	
24	1.000	.250	.500	—	2	1.500	30	Silver plated
25	1.625	.250	.562	1.125	3	2.125	20	
26	2.125	.312	.750	1.500	3	2.625	10	

CLR25

MIL-C-39006 PART NUMBER SYSTEM

M39006 01 3001*

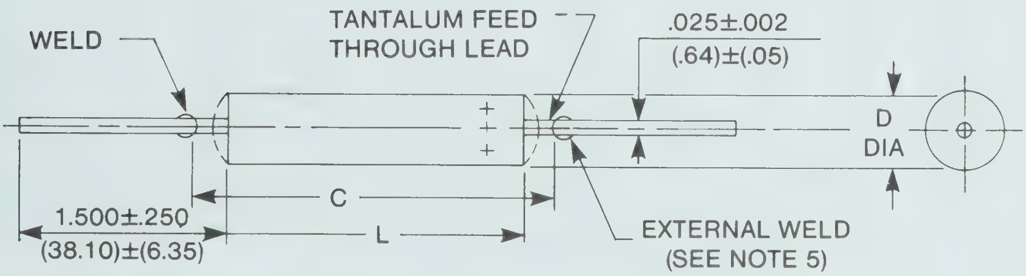
Abbreviated form of MIL-C-39006

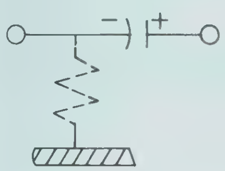
Sequential dash number from table. For specific value of capacitance, tolerance, voltage, case size and failure rate level the table must be consulted.
*Add the letter "H" to indicate optional Random Vibration requirement.

DETAIL SHEET FOR APPLICABLE STYLE:

01: Style CLR 25—Polar Etched
02: Style CLR 27—Nonpolar Etched
03: Style CLR 35—Polar Plain
04: Style CLR 37—Nonpolar Plain
16: Style CLR 71—Polar High Etched
17: Style CLR 73—Nonpolar High Etched

OUTLINE DRAWING AND DIMENSIONS





CASE
CIRCUIT DIAGRAM
(SEE NOTE 4)

Case size	Dimensions			
	Basic case		Insulated case	
	L* ±.062 (1.57)	D ±.016 (.41)	D Max	C Max
E1	.688 (17.48)	.188 (4.78)	.219 (5.56)	1.188 (30.18)
E2	.906 (23.01)	.281 (7.14)	.312 (7.92)	1.406 (35.71)
G2	.969 (24.61)	.281 (7.14)	.312 (7.92)	1.469 (37.31)
E3, G3	1.438 (36.53)	.375 (9.53)	.406 (10.31)	1.938 (49.23)
E4, G4	2.125 (53.98)	.375 (9.53)	.406 (10.31)	2.625 (66.68)
E5, G5	2.750 (69.85)	.375 (9.53)	.406 (10.31)	3.250 (82.55)

Length of basic case; sleeving shall be as specified in MIL-C-39006.

NOTES:
1. Dimensions are in inches.
2. Millimeters are in parentheses.
3. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.
4. There is an indeterminate resistance between the metal case and the negative terminal.
5. The weld shall not be enclosed in the end seal.

MIL-C-39006

Military Style Tantalum Capacitors

MIL-C-39006/01
STYLE CLR25

Rated voltage (85 C)	Cap.	Cap. tolerance	DC leakage (max) 25 C	DC leakage (max) 85 C & 125 C	Derated voltage (125 C)	Surge voltage (85 C)	Impedance (max)	Case size	Part No. M39006/01- Failure rate level (%/1,000 hr) L(2.0)	M(1.0)	P(0.1)	R(0.01)	S(0.001)
HERMETICALLY-SEALED													
volts, dc	uF	%	uA	uA	volts, dc	volts, dc	ohms						
15	60.0	+75, -15	2	10	10	17.2	55	G2	3001	3030	3059	3088	3117
15	200.0	+75, -15	3	40	10	17.2	17	G3	3002	3031	3060	3089	3118
15	400.0	+75, -15	6	80	10	17.2	9	G4	3003	3032	3061	3090	3119
15	580.0	+75, -15	9	100	10	17.2	6	G5	3004	3033	3062	3091	3120
25	40.0	+75, -15	2	13	15	28.8	83	G2	3005	3034	3063	3092	3121
25	120.0	+75, -15	3	40	15	28.8	27	G3	3006	3035	3064	3093	3122
25	250.0	+75, -15	6	80	15	28.8	13	G4	3007	3036	3065	3094	3123
25	350.0	+75, -15	10	100	15	28.8	10	G5	3008	3037	3066	3095	3124
30	32.0	+75, -15	2	14	20	34.5	106	G2	3009	3038	3067	3096	3125
30	110.0	+75, -15	4	50	20	34.5	31	G3	3010	3039	3068	3097	3126
30	220.0	+75, -15	8	90	20	34.5	16	G4	3011	3040	3069	3098	3127
30	300.0	+75, -15	11	120	20	34.5	11	G5	3012	3041	3070	3099	3128
50	18.0	+50, -15	2	13	30	57.5	180	G2	3013	3042	3071	3100	3129
50	60.0	+50, -15	3	40	30	57.5	55	G3	3014	3043	3072	3101	3130
50	75.0	+50, -15	4	70	30	57.5	52	G3	3200	3201	3203	3204	3205
50	100.0	+50, -15	4	75	30	57.5	33	G4	3016	3045	3074	3103	3132
50	150.0	+50, -15	5	100	30	57.5	22	G5	3017	3046	3075	3104	3133
75	12.0	+50, -15	2	13	50	86.2	270	G2	3018	3047	3076	3105	3134
75	30.0	+50, -15	3	34	50	86.2	110	G3	3019	3048	3077	3106	3135
75	70.0	+50, -15	6	80	50	86.2	47	G4	3020	3049	3078	3107	3136
75	100.0	+50, -15	10	100	50	86.2	33	G5	3021	3050	3079	3108	3137
100	8.0	+30, -15	2	12	65	115.0	410	G2	3022	3051	3080	3109	3138
100	25.0	+30, -15	2.5	37	65	115.0	130	G3	3023	3052	3081	3110	3139
100	50.0	+30, -15	5	75	65	115.0	66	G4	3024	3053	3082	3111	3140
100	70.0	+30, -15	7	100	65	115.0	47	G5	3025	3054	3083	3112	3141
150	4.0	+30, -15	2	13	100	172.0	750	G2	3026	3055	3084	3113	3142
150	13.0	+30, -15	3	30	100	172.0	250	G3	3027	3056	3085	3114	3143
150	25.0	+30, -15	5	80	100	172.0	130	G4	3028	3057	3086	3115	3144
150	36.0	+30, -15	8	100	100	172.0	94	G5	3029	3058	3087	3116	3145
NONHERMETICALLY-SEALED													
15	15.0	+75, -15	2	4	10	17.2	220	E1	2200	2232	2264	2296	2328
25	10.0	+75, -15	2	4	15	28.8	330	E1	2205	2237	2269	2301	2333
30	8.0	+75, -15	2	6	20	34.5	424	E1	2210	2242	2274	2306	2338
50	4.5	+50, -15	2	4	30	57.5	730	E1	2212	2244	2276	2308	2340
75	3.0	+50, -15	2	4	50	86.2	1000	E1	2217	2249	2281	2313	2345
100	2.0	+30, -15	2	4	65	115.0	1600	E1	2222	2254	2286	2318	2350
150	1.0	+30, -15	2	4	100	172.0	3000	E1	2227	2259	2291	2323	2355

☐ Shaded area denotes failure rate levels not available at time of this printing. Refer to your Philips Components sales person or factory for latest update.

MIL-C-39006/02
STYLE CLR27

Rated voltage (85°C)	Cap.	Cap. tolerance	DC leakage (max) 25°C	DC leakage (max) 85°C & 125°C	Derated voltage (125°C)	Surge voltage (85°C)	Impedance (max)	Case size	Part No. M39006/02- Failure rate level (%/1,000 hr) L(2.0)	M(1.0)	P(0.1)	R(0.01)	S(0.001)
volts, dc	uF	%	uA	uA	volts, dc	volts, dc	ohms						
HERMETICALLY-SEALED													
15	40	+75, -15	2	10	10	17.2	85	G2	1200	1228	1256	1284	1312
15	120	+75, -15	3	40	10	17.2	27	G3	1201	1229	1257	1285	1313
15	250	+75, -15	6	80	10	17.2	14	G4	1202	1230	1258	1286	1314
15	350	+75, -15	9	100	10	17.2	10	G5	1203	1231	1259	1287	1315
25	20	+75, -15	2	13	15	28.8	170	G2	1204	1232	1260	1288	1316
25	70	+75, -15	3	40	15	28.8	49	G3	1205	1233	1261	1289	1317
25	140	+75, -15	6	80	15	28.8	24	G4	1206	1234	1262	1290	1318
25	200	+75, -15	10	100	15	28.8	17	G5	1207	1235	1263	1291	1319
30	18	+75, -15	2	14	20	34.5	188	G2	1208	1236	1264	1292	1320
30	60	+75, -15	4	50	20	34.5	57	G3	1209	1237	1265	1293	1321
30	120	+75, -15	8	90	20	34.5	28	G4	1210	1238	1266	1294	1322
30	170	+75, -15	11	120	20	34.5	20	G5	1211	1239	1267	1295	1323
50	10	+50, -15	2	13	30	57.5	339	G2	1212	1240	1268	1296	1324
50	30	+50, -15	3	40	30	57.5	113	G3	1213	1241	1269	1297	1325
50	60	+50, -15	4	75	30	57.5	57	G4	1214	1242	1270	1298	1326
50	80	+50, -15	5	100	30	57.5	41	G5	1215	1243	1271	1299	1327
75	6	+50, -15	2	13	50	86.2	560	G2	1216	1244	1272	1300	1328
75	15	+50, -15	3	34	50	86.2	226	G3	1217	1245	1273	1301	1329
75	35	+50, -15	5	80	50	86.2	97	G4	1218	1246	1274	1302	1330
75	50	+50, -15	10	100	50	86.2	68	G5	1219	1247	1275	1303	1331
100	4	+30, -15	2	13	65	115.0	845	G2	1220	1248	1276	1304	1332
100	12	+30, -15	3	37	65	115.0	283	G3	1221	1249	1277	1305	1333
100	25	+30, -15	5	75	65	115.0	135	G4	1222	1250	1278	1306	1334
100	35	+30, -15	7	100	65	115.0	97	G5	1223	1251	1279	1307	1335
150	2	+30, -15	2	13	100	172.0	1693	G2	1224	1252	1280	1308	1336
150	6	+30, -15	3	30	100	172.0	565	G3	1225	1253	1281	1309	1337
150	12	+30, -15	5	80	100	172.0	283	G4	1226	1254	1282	1310	1338
150	18	+30, -15	8	100	100	172.0	188	G5	1227	1255	1283	1311	1339
NONHERMETICALLY-SEALED													
15	10	+75, -15	2	4	10	17.2	339	E1	2200	2232	2264	2296	2328
25	5	+75, -15	2	4	15	28.8	680	E1	2205	2237	2269	2301	2333
30	4.5	+75, -15	2	6	20	34.5	754	E1	2210	2242	2274	2306	2338
50	2.5	+50, -15	2	4	30	57.5	1355	E1	2212	2244	2276	2308	2340
75	1.5	+50, -15	2	4	50	86.2	2255	E1	2217	2249	2281	2313	2345
100	1	+30, -15	2	4	65	115.0	3385	E1	2222	2254	2286	2318	2350
150	0.5	+30, -15	2	4	100	172.0	6780	E1	2227	2259	2291	2323	2355

☐ Shaded area denotes failure rate levels not available at time of this printing. Refer to your Philips Components sales person or factory for latest update.

MIL-C-39006
Military Style Tantalum Capacitors

MIL-C-39006/03
STYLE CLR35

3

Tantalum Capacitors

Rated voltage (85 C)	Cap.	Cap. tolerance	DC leakage (max) 25 C	DC leakage (max) 85 C & 125 C	Derated voltage (125 C)	Surge voltage (85 C)	Impedance (max)	Case size	Part No. M39006/03- Failure rate level (%/1,000 hr) L(2.0)	M(1.0)	P(0.1)	R(0.01)	S(0.001)
HERMETICALLY-SEALED													
volts, dc	uF	%	uA	uA	volts, dc	volts, dc	ohms						
15	18.0	±20	2	4	10	17.2	125	G2	1300	1349	1398	1447	1496
15	55.0	±20	2	10	10	17.2	41	G3	1301	1350	1399	1448	1497
15	110.0	±20	4	20	10	17.2	20	G4	1302	1351	1400	1449	1498
15	160.0	±20	5	30	10	17.2	14	G5	1303	1352	1401	1450	1499
25	12.0	±20	2	4	15	28.8	186	G2	1304	1353	1402	1451	1500
25	35.0	±20	2	10	15	28.8	64	G3	1305	1354	1403	1452	1501
25	70.0	±20	4	20	15	28.8	32	G4	1306	1355	1404	1453	1502
25	100.0	±20	6	30	15	28.8	23	G5	1307	1356	1405	1454	1503
30	10.0	±20	2	6	20	34.5	265	G2	1308	1357	1406	1455	1504
30	30.0	±20	2	13	20	34.5	75	G3	1309	1358	1407	1456	1505
30	60.0	±20	4	26	20	34.5	37	G4	1310	1359	1408	1457	1506
30	85.0	±20	6	38	20	34.5	27	G5	1311	1360	1409	1458	1507
35	68.0	±20	5	25	25	40.2	40	G5	1312	1361	1410	1459	1508
50	6.0	±20	2	6	30	57.5	372	G2	1313	1362	1411	1460	1509
50	20.0	±20	2	13	30	57.5	112	G3	1314	1363	1412	1461	1510
50	40.0	±20	4	26	30	57.5	56	G4	1315	1364	1413	1462	1511
50	55.0	±20	6	38	30	57.5	41	G5	1316	1365	1414	1463	1512
75	4.0	±20	2	6	50	86.2	558	G2	1317	1366	1415	1464	1513
75	14.0	±20	2	13	50	86.2	159	G3	1318	1367	1416	1465	1514
75	28.0	±20	4	26	50	86.2	80	G4	1319	1368	1417	1466	1515
75	40.0	±20	6	38	50	86.2	56	G5	1320	1369	1418	1467	1516
100	3.0	±20	2	6	65	115.0	743	G2	1321	1370	1419	1468	1517
100	10.0	±20	2	13	65	115.0	223	G3	1322	1371	1420	1469	1518
100	20.0	±20	3	25	65	115.0	112	G4	1323	1372	1421	1470	1519
100	30.0	±20	6	38	65	115.0	74	G5	1324	1373	1422	1471	1520
150	2.0	±20	2	6	100	172.0	1115	G2	1325	1374	1423	1472	1521
150	7.0	±20	3	13	100	172.0	319	G3	1326	1375	1424	1473	1522
150	14.0	±20	4	26	100	172.0	159	G4	1327	1376	1425	1474	1523
150	20.0	±20	6	38	100	172.0	112	G5	1328	1377	1426	1475	1524
200	1.5	±15	8	32	150	230.0	1300	G2	1329	1378	1427	1476	1525
200	5.0	±15	16	64	150	230.0	400	G3	1330	1379	1428	1477	1526
200	10.0	±15	28	100	150	230.0	200	G4	1331	1380	1429	1478	1527
200	15.0	±15	40	160	150	230.0	130	G5	1332	1381	1430	1479	1528
NONHERMETICALLY-SEALED													
15	4.5	±20	1	2	10	17.2	495	E1	2300	2360	2420	2480	2540
25	3.0	±20	1	2	15	28.8	744	E1	2305	2365	2425	2485	2545
30	2.5	±20	2	5	20	34.5	893	E1	2310	2370	2430	2490	2550
50	1.5	±20	1	4	30	57.5	1487	E1	2315	2375	2435	2495	2555
75	1.0	±20	1	4	50	86.2	2232	E1	2320	2380	2440	2500	2560
100	0.8	±20	1	3.5	65	115.0	2790	E1	2325	2385	2445	2505	2565
150	0.5	±20	2	4	100	172.0	4454	E1	2330	2390	2450	2510	2570
200	0.35	±15	4	25	150	230.0	5577	E1	2335	2395	2455	2515	2575

☐ Shaded area denotes failure rate levels not available at time of this printing. Refer to your Philips Components sales person or factory for latest update.

MIL-C-39006

Military Style Tantalum Capacitors

MIL-C-39006/04
STYLE CLR37

Rated voltage (85°C)	Cap.	Cap. tolerance	DC leakage (max) 25°C	DC leakage (max) 85°C & 125°C	Derated voltage (125°C)	Surge voltage (85°C)	Imped-ance (max)	Case size)	Part No. M39006/04 Failure rate level (%/1,000 hr) L(2.0)	M(1.0)	P(0.1)	R(0.01)	S(0.001)
HERMETICALLY-SEALED													
volts, dc	uF	%	uA	uA	volts, dc	volts, dc	ohms						
15	10.0	±20	2	4	10	17.2	223	G2	1200	1245	1290	1335	1380
15	35.0	±20	2	10	10	17.2	64	G3	1201	1246	1291	1336	1381
15	70.0	±20	4	20	10	17.2	32	G4	1202	1247	1292	1337	1382
15	100.0	±20	5	30	10	17.2	23	G5	1203	1248	1293	1338	1383
25	6.0	±20	2	6	15	28.8	372	G2	1204	1249	1294	1339	1384
25	20.0	±20	2	10	15	28.8	112	G3	1205	1250	1295	1340	1385
25	40.0	±20	4	20	15	28.8	56	G4	1206	1251	1296	1341	1386
25	60.0	±20	5	30	15	28.8	37	G5	1207	1252	1297	1342	1387
30	5.5	±20	2	6	20	34.5	406	G2	1208	1253	1298	1343	1388
30	18.0	±20	2	12	20	34.5	124	G3	1209	1254	1299	1344	1389
30	36.0	±20	4	26	20	34.5	62	G4	1210	1255	1300	1345	1390
30	45.0	±20	6	36	20	34.5	50	G5	1211	1256	1301	1346	1391
50	3.0	±20	2	6	30	57.5	743	G2	1212	1257	1302	1347	1392
50	10.0	±20	2	12	30	57.5	223	G3	1213	1258	1303	1348	1393
50	20.0	±20	4	24	30	57.5	112	G4	1214	1259	1304	1349	1394
50	30.0	±20	6	36	30	57.5	75	G5	1215	1260	1305	1350	1395
75	2.0	±20	2	6	50	86.2	1115	G2	1216	1261	1306	1351	1396
75	7.0	±20	2	13	50	86.2	319	G3	1217	1262	1307	1352	1397
75	14.0	±20	4	24	50	86.2	159	G4	1218	1263	1308	1353	1398
75	20.0	±20	6	36	50	86.2	112	G5	1219	1264	1309	1354	1399
100	1.5	±20	2	6	65	115.0	1487	G2	1220	1265	1310	1355	1400
100	5.0	±20	2	13	65	115.0	446	G3	1221	1266	1311	1356	1401
100	10.0	±20	4	24	65	115.0	223	G4	1222	1267	1312	1357	1402
100	15.0	±20	6	36	65	115.0	149	G5	1223	1268	1313	1358	1403
150	1.0	±20	2	6	100	172.0	2227	G2	1224	1269	1314	1359	1404
150	1.2	±20	3	12	100	172.0	2000	G2	1225	1270	1315	1360	1405
150	3.5	±20	3	13	100	172.0	638	G3	1226	1271	1316	1361	1406
150	7.0	±20	4	24	100	172.0	319	G4	1227	1272	1317	1362	1407
150	10.0	±20	6	36	100	172.0	223	G5	1228	1273	1318	1363	1408
200	0.75	±15	8	32	150	230.0	2700	G2	1229	1274	1319	1364	1409
200	2.5	±15	16	64	150	230.0	800	G3	1230	1275	1320	1365	1410
200	5.0	±15	28	112	150	230.0	400	G4	1231	1276	1321	1366	1411
200	7.5	±15	40	160	150	230.0	260	G5	1232	1277	1322	1367	1412
NONHERMETICALLY-SEALED													
15	2.5	±20	1	2	10	17.2	893	E1	2300	2355	2410	2465	2520
25	1.5	±20	1	3	15	28.8	1487	E1	2305	2360	2415	2470	2525
30	1.4	±20	2	5	20	34.5	1594	E1	2310	2365	2420	2475	2530
50	0.8	±20	1	4	30	57.5	2790	E1	2315	2370	2425	2480	2535
75	0.5	±20	1	4	50	86.2	4460	E1	2320	2375	2430	2485	2540
100	0.4	±20	1	3.5	65	115.0	5580	E1	2325	2380	2435	2490	2545
150	0.25	±20	1	4	100	172.0	8909	E1	2330	2385	2440	2495	2550
200	0.15	±15	4	25	150	230.0	14000	E1	2335	2390	2445	2500	2555

☐ Shaded area denotes failure rate levels not available at time of this printing. Refer to your Philips Components sales person or factory for latest update.

MIL-C-39006

Military Style Tantalum Capacitors

MIL-C-39006/16
STYLE CLR71

Rated voltage (85 C)	Cap.	Cap. tolerance	DC leakage (max) 25 C	DC leakage (max) 85 C	DC leakage (max) 125 C	Derated voltage (125°C)	Surge voltage (85°C)	Impedance (max)	Case size	Part No. M39006/16- Failure rate level (%/1,000 hr) L(2.0)	M(1.0)	P(0.1)	R(0.01)	S(0.001)
volts, dc	uF	%	uA	uA	uA	volts, dc	volts, dc	ohms						
HERMETICALLY-SEALED														
15	100	+75, -15	23	100	80	10	17.2	37	G2	2001	2036	2071	2106	2141
15	310	+75, -15	61	370	250	10	17.2	10.8	G3	2002	2037	2072	2107	2142
15	650	+75, -15	130	780	520	10	17.2	5.1	G4	2003	2038	2073	2108	2143
15	920	+75, -15	185	1100	750	10	17.2	4.0	G5	2004	2039	2074	2109	2144
25	60	+75, -15	23	100	72	15	28.8	62	G2	2006	2041	2076	2111	2146
25	180	+75, -15	60	360	220	15	28.8	20.5	G3	2007	2042	2077	2112	2147
25	380	+75, -15	125	760	460	15	28.8	9.6	G4	2008	2043	2078	2113	2148
25	550	+75, -15	185	1100	660	15	28.8	6.7	G5	2009	2044	2079	2114	2149
30	52	+75, -15	23	120	80	20	34.5	71	G2	2011	2046	2081	2116	2151
30	150	+75, -15	60	360	240	20	34.5	25	G3	2012	2047	2082	2117	2152
30	320	+75, -15	125	750	500	20	34.5	11.5	G4	2013	2048	2083	2118	2153
30	460	+75, -15	165	1000	700	20	34.5	8	G5	2014	2049	2084	2119	2154
50	25	+50, -15	19	100	60	30	57.5	150	G2	2016	2051	2086	2121	2156
50	75	+50, -15	50	300	180	30	57.5	49	G3	2017	2052	2087	2122	2157
50	160	+50, -15	100	640	390	30	57.5	23	G4	2018	2053	2088	2123	2158
50	230	+50, -15	150	920	550	30	57.5	16	G5	2019	2054	2089	2124	2159
75	15	+50, -15	17	90	60	50	86.2	250	G2	2021	2056	2091	2126	2161
75	45	+50, -15	45	270	180	50	86.2	83	G3	2022	2057	2092	2127	2162
75	95	+50, -15	95	570	380	50	86.2	39	G4	2023	2058	2093	2128	2163
75	130	+50, -15	130	780	520	50	86.2	29	G5	2024	2059	2094	2129	2164
100	10	+30, -15	15	80	52	65	115.0	370	G2	2026	2061	2096	2131	2166
100	30	+30, -15	40	230	150	65	115.0	121	G3	2027	2062	2097	2132	2167
100	63	+30, -15	80	480	310	65	115.0	58	G4	2028	2063	2098	2133	2168
100	90	+30, -15	120	720	470	65	115.0	41	G5	2029	2064	2099	2134	2169
150	5.5	+30, -15	12	64	42	100	172.0	675	G2	2031	2066	2101	2136	2171
150	17	+30, -15	30	190	130	100	172.0	220	G3	2032	2067	2102	2137	2172
150	35	+30, -15	65	400	260	100	172.0	106	G4	2033	2068	2103	2138	2173
150	50	+30, -15	95	560	380	100	172.0	74	G5	2034	2069	2104	2139	2174
NONHERMETICALLY SEALED														
15	29	+75, -15	7	35	23	10	17.2	137	E1	1000	1035	1070	1105	1140
15	100	+75, -15	23	100	80	10	17.2	37	E2	1001	1036	1071	1106	1141
15	310	+75, -15	61	370	250	10	17.2	10.8	E3	1002	1037	1072	1107	1142
15	650	+75, -15	130	780	520	10	17.2	5.1	E4	1003	1038	1073	1108	1143
15	920	+75, -15	185	1100	750	10	17.2	4.0	E5	1004	1039	1074	1109	1144
25	17	+75, -15	6	34	21	15	28.8	220	E1	1005	1040	1075	1110	1145
25	60	+75, -15	23	100	72	15	28.8	62	E2	1006	1041	1076	1111	1146
25	180	+75, -15	60	360	220	15	28.8	20.5	E3	1007	1042	1077	1112	1147
25	380	+75, -15	125	760	460	15	28.8	9.6	E4	1008	1043	1078	1113	1148
25	550	+75, -15	185	1100	660	15	28.8	6.7	E5	1009	1044	1079	1114	1149
30	15	+75, -15	6	34	22	20	34.5	250	E1	1010	1045	1080	1115	1150
30	52	+75, -15	23	120	80	20	34.5	71	E2	1011	1046	1081	1116	1151
30	150	+75, -15	60	360	240	20	34.5	25	E3	1012	1047	1082	1117	1152
30	320	+75, -15	125	750	500	20	34.5	11.5	E4	1013	1048	1083	1118	1153
30	460	+75, -15	165	1000	700	20	34.5	8	E5	1014	1049	1084	1119	1154
50	7	+50, -15	5	28	17	30	57.5	550	E1	1015	1050	1085	1120	1155
50	25	+50, -15	19	100	60	30	57.5	150	E2	1016	1051	1086	1121	1156
50	75	+50, -15	50	300	180	30	57.5	49	E3	1017	1052	1087	1122	1157
50	160	+50, -15	100	640	390	30	57.5	23	E4	1018	1053	1088	1123	1158
50	230	+50, -15	150	920	550	30	57.5	16	E5	1019	1054	1089	1124	1159
75	4	+50, -15	5	24	16	50	86.2	930	E1	1020	1055	1090	1125	1160
75	15	+50, -15	17	90	60	50	86.2	250	E2	1021	1056	1091	1126	1161
75	45	+50, -15	45	270	180	50	86.2	83	E3	1022	1057	1092	1127	1162
75	95	+50, -15	95	570	380	50	86.2	39	E4	1023	1058	1093	1128	1163
75	130	+50, -15	130	780	520	50	86.2	29	E5	1024	1059	1094	1129	1164
100	3	+30, -15	4	20	14	65	115.0	1210	E1	1025	1060	1095	1130	1165
100	10	+30, -15	15	80	52	65	115.0	370	E2	1026	1061	1096	1131	1166
100	30	+30, -15	40	230	150	65	115.0	121	E3	1027	1062	1097	1132	1167
100	63	+30, -15	80	480	310	65	115.0	58	E4	1028	1063	1098	1133	1168
100	90	+30, -15	120	720	470	65	115.0	41	E5	1029	1064	1099	1134	1169
150	1.6	+30, -15	3	18	12	100	172.0	2340	E1	1030	1065	1100	1135	1170
150	5.5	+30, -15	12	64	42	100	172.0	675	E2	1031	1066	1101	1136	1171
150	17	+30, -15	30	190	130	100	172.0	220	E3	1032	1067	1102	1137	1172
150	35	+30, -15	65	400	260	100	172.0	106	E4	1033	1068	1103	1138	1173
150	50	+30, -15	95	560	380	100	172.0	74	E5	1034	1069	1104	1139	1174

☐ Shaded area denotes failure rate levels not available at time of printing. Refer to your Philips Components sales person or factory for latest update.

MIL-C-39006/17
STYLE CLR73

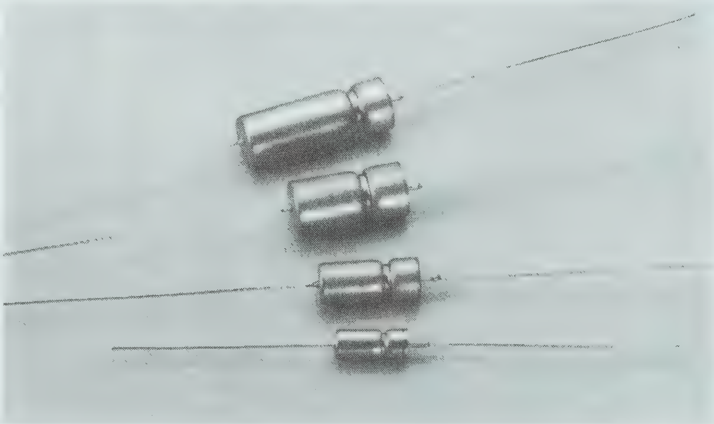
Rated voltage (85°C)	Cap.	Cap. tolerance	DC leakage (max) 25°C	85°C	125°C	Derated voltage (125°C)	Surge voltage (85°C)	Impedance (max)	Case size	Part No. M39006/17- Failure rate level (%/1,000 hr) L(2.0)	M(1.0)	P(0.1)	R(0.01)	S(0.001)
						HERMETICALLY SEALED								
volts, dc	uF	%	uA	uA	uA	volts, dc	volts, dc	ohms						
15	70.0	+75, -15	15	84	56	10	17.2	55	G2	2001	2036	2071	2106	2141
15	200.0	+75, -15	40	240	160	10	17.2	18.5	G3	2002	2037	2072	2107	2142
15	410.0	+75, -15	75	500	330	10	17.2	8.9	G4	2003	2038	2073	2108	2143
15	590.0	+75, -15	118	710	470	10	17.2	6.2	G5	2004	2039	2074	2109	2144
25	35.0	+75, -15	12	70	43	15	28.8	106	G2	2006	2041	2076	2111	2146
25	100.0	+75, -15	30	200	120	15	28.8	37	G3	2007	2042	2077	2112	2147
25	210.0	+75, -15	40	400	250	15	28.8	17.5	G4	2008	2043	2078	2113	2148
25	300.0	+75, -15	100	600	360	15	28.8	12.1	G5	2009	2044	2079	2114	2149
30	29.0	+75, -15	11	60	40	20	34.5	137	G2	2011	2046	2081	2116	2151
30	80.0	+75, -15	30	180	120	20	34.5	45.5	G3	2012	2047	2082	2117	2152
30	170.0	+75, -15	65	390	260	20	34.5	22	G4	2013	2048	2083	2118	2153
30	240.0	+75, -15	90	550	370	20	34.5	7.8	G5	2014	2049	2084	2119	2154
50	13.0	+50, -15	10	52	31	30	57.5	285	G2	2016	2051	2086	2121	2156
50	36.0	+50, -15	24	145	86	30	57.5	104	G3	2017	2052	2087	2122	2157
50	75.0	+50, -15	45	300	180	30	57.5	49	G4	2018	2053	2088	2123	2158
50	110.0	+50, -15	75	440	260	30	57.5	34	G5	2019	2054	2089	2124	2159
75	7.0	+50, -15	8	42	28	50	86.2	550	G2	2021	2056	2091	2126	2161
75	20.0	+50, -15	23	120	80	50	86.2	185	G3	2022	2057	2092	2127	2162
75	43.0	+50, -15	45	260	170	50	86.2	86	G4	2023	2058	2093	2128	2163
75	60.0	+50, -15	60	360	240	50	86.2	62	G5	2024	2059	2094	2129	2164
100	5.0	+30, -15	7	38	25	65	115.0	750	G2	2026	2061	2096	2131	2166
100	14.0	+30, -15	15	110	68	65	115.0	268	G3	2027	2062	2097	2132	2167
100	29.0	+30, -15	35	220	145	65	115.0	137	G4	2028	2063	2098	2133	2168
100	41.0	+30, -15	50	320	210	65	115.0	91	G5	2029	2064	2099	2134	2169
150	2.7	+30, -15	6	30	20	100	172.0	1380	G2	2031	2066	2101	2136	2171
150	7.5	+30, -15	15	84	56	100	172.0	490	G3	2032	2067	2102	2137	2172
150	15.0	+30, -15	30	180	120	100	172.0	250	G4	2033	2068	2103	2138	2173
150	22.0	+30, -15	45	270	175	100	172.0	170	G5	2034	2069	2104	2139	2174
						NONHERMETICALLY SEALED								
15	20.0	+75, -15	5	24	16	10	17.2	185	E1	1000	1035	1070	1105	1140
15	70.0	+75, -15	15	84	56	10	17.2	55	E2	1001	1036	1071	1106	1141
15	200.0	+75, -15	40	240	160	10	17.2	18.5	E3	1002	1037	1072	1107	1142
15	410.0	+75, -15	75	500	330	10	17.2	8.9	E4	1003	1038	1073	1108	1143
15	590.0	+75, -15	118	710	470	10	17.2	6.2	E5	1004	1039	1074	1109	1144
25	10.0	+75, -15	4	20	12	15	28.8	370	E1	1005	1040	1075	1110	1145
25	35.0	+75, -15	12	70	43	15	28.8	106	E2	1006	1041	1076	1111	1146
25	100.0	+75, -15	30	200	120	15	28.8	37	E3	1007	1042	1077	1112	1147
25	210.0	+75, -15	40	400	250	15	28.8	17.5	E4	1008	1043	1078	1113	1148
25	300.0	+75, -15	100	600	360	15	28.8	12.1	E5	1009	1044	1079	1114	1149
30	8.0	+75, -15	3	19	12	20	34.5	455	E1	1010	1045	1080	1115	1150
30	29.0	+75, -15	11	60	40	20	34.5	137	E2	1011	1046	1081	1116	1151
30	80.0	+75, -15	30	180	120	20	34.5	45.5	E3	1012	1047	1082	1117	1152
30	170.0	+75, -15	65	390	260	20	34.5	22	E4	1013	1048	1083	1118	1153
30	240.0	+75, -15	90	550	370	20	34.5	7.8	E5	1014	1049	1084	1119	1154
50	3.5	+50, -15	3	14	9	30	57.5	1060	E1	1015	1050	1085	1120	1155
50	13.0	+50, -15	10	52	31	30	57.5	285	E2	1016	1051	1086	1121	1156
50	36.0	+50, -15	24	145	86	30	57.5	104	E3	1017	1052	1087	1122	1157
50	75.0	+50, -15	45	300	180	30	57.5	49	E4	1018	1053	1088	1123	1158
50	110.0	+50, -15	75	440	260	30	57.5	34	E5	1019	1054	1089	1124	1159
75	2.0	+50, -15	2	12	8	50	86.2	1850	E1	1020	1055	1090	1125	1160
75	7.0	+50, -15	8	42	28	50	86.2	550	E2	1021	1056	1091	1126	1161
75	20.0	+50, -15	23	120	80	50	86.2	185	E3	1022	1057	1092	1127	1162
75	43.0	+50, -15	45	260	170	50	86.2	86	E4	1023	1058	1093	1128	1163
75	60.0	+50, -15	60	360	240	50	86.2	62	E5	1024	1059	1094	1129	1164
100	1.4	+30, -15	2	11	7	65	115.0	2700	E1	1025	1060	1095	1130	1165
100	5.0	+30, -15	7	38	25	65	115.0	750	E2	1026	1061	1096	1131	1166
100	14.0	+30, -15	15	110	68	65	115.0	268	E3	1027	1062	1097	1132	1167
100	29.0	+30, -15	35	220	145	65	115.0	137	E4	1028	1063	1098	1133	1168
100	41.0	+30, -15	50	320	210	65	115.0	91	E5	1029	1064	1099	1134	1169
150	0.75	+30, -15	2	9	6	100	172.0	5000	E1	1030	1065	1100	1135	1170
150	2.7	+30, -15	6	30	20	100	172.0	1380	E2	1031	1066	1101	1136	1171
150	7.5	+30, -15	15	84	56	100	172.0	490	E3	1032	1067	1102	1137	1172
150	15.0	+30, -15	30	180	120	100	172.0	250	E4	1033	1068	1103	1138	1173
150	22.0	+30, -15	45	270	175	100	172.0	170	E5	1034	1069	1104	1139	1174

Shaded area denotes failure rate levels not available at time of this printing. Refer to your Philips Components sales person or factory for latest update.

SERIES 40AW

Tantalum Case Hermetically Sealed Tubular Tantalum Wet-Slug Capacitor

−55°C to 125°C 1.7 to 1200 μF
4-125 Volts DC



DESCRIPTION

The 40AW capacitor is an all tantalum cased high reliability porous anode type with a glass to tantalum hermetic seal. This type capacitor is primarily suited for military and aerospace application. This capacitor meets or exceeds all requirements of MIL-C-39006/22.

These capacitors are ideal for such functions as filtering, by-passing, coupling and timing in applications where minimum size and weight conditions must be achieved and reverse voltage up to 3VDC, or high ripple currents, are required.

GLASS-TO-TANTALUM SEAL

The glass-to-tantalum seal is one unique feature of the 40AW Series. This seal differs from other hermetic seals in that it is a tantalum feed-through seal. This construction provides a true glass-to-tantalum seal.

TANTALUM CASE

Use of a tantalum case and tantalum powder cathode permits 3VDC reverse capability without harm; and the sintered powder cathode allows higher vibration and shock levels than comparable silver cased devices.

FEATURES

- ALL TANTALUM CONSTRUCTION
- REVERSE VOLTAGE CAPABILITY OF 3VDC
- HIGH RIPPLE CURRENT
- LONG LIFE
- RATED FOR −55°C TO 125°C OPERATION
- EXTENDED RANGE CAPACITANCE AVAILABLE CONSULT FACTORY FOR DETAILS

WARNING

NON-SOLID ELECTROLYTIC CAPACITORS MAY CONTAIN CHEMICALS WHICH CAN BE REGARDED AS HAZARDOUS IF HANDLED INCORRECTLY. CAUTION IS NECESSARY IF THE OUTER CASE IS FRACTURED.

SERIES 40AW
Industrial Type Tantalum Capacitors

DIMENSIONS

OUTLINE DRAWING

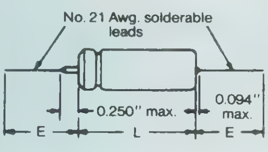


FIG. 1 UNINSULATED

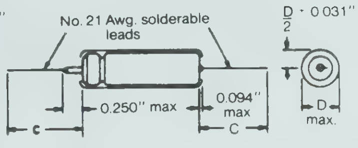


FIG.2 INSULATED

OUTLINE DIMENSIONS

Case Code		Dimensions — Inches (mm)					Approximate Weight (Grams)
		Basic Case		Insulated Case			
Type 40AW	MIL Equiv.	L +.031 (.79) −.016 (.41)	D ±.016 (.41)	D max	E ±.250 (6.35)	d ±.002 (.05)	
A	T1	.453 (11.51)	.188 (4.78)	.219 (5.56)	1.500 (38.10)	.025 (.64)	2.0
B	T2	.641 (16.28)	.281 (7.14)	.312 (7.92)	2.250 (57.15)	.025 (.64)	5.1
C	T3	.766 (19.48)	.375 (9.53)	.406 (10.31)	2.250 (57.15)	.025 (.64)	9.0
D	T4	1.062 (26.97)	.375 (9.53)	.406 (10.31)	2.250 (57.15)	.025 (.64)	14.5

Length of basic case; sleeving shall lap over the ends of the capacitor body. Non-shrinkable sleeving extends .016 inch minimum, .062 inch maximum beyond each end of the case.

STANDARD RATINGS

μF	Case Code	Catalog Number ·	Max. DF at 25°C and 120 Hz %	Max. Impedance at −55°C and 120 Hz (Ω)	Max. D-C Leakage Current at 25°C (μA)	Max. D-C Leakage Current at 85°C & 125°C (μA)	Maximum Capacitance Change in Percent at −55°C	+85°C	+125°C	Max. RMS Ripple Current AT 40 KHz (mA)
		6 VOLTS D-C AT 85°C, 4 VOLTS D-C AT 125°C								
30	A	40AW306A006KIA	9.0	100	1.0	2.0	−40	10.5	12	820
68	A	40AW686A006KIA	15.0	60	1.0	2.0	−40	14	16	960
140	B	40AW147B006KIA	21.0	40	1.0	3.0	−40	14	16	1200
270	B	40AW277B006KIA	45.0	25	1.0	6.5	−44	17.5	20	1375
330	C	40AW337C006KIA	36.0	20	2.0	7.9	−44	14	16	1800
560	C	40AW567C006KIA	55.0	25	2.0	1.3	−64	17.5	20	1900
1200	D	40AW128D006KIA	90.0	20	3.0	14.0	−80	25	25	2265
		8 VOLTS D-C AT 85°C, 5 VOLTS D-C AT 125°C								
25	A	40AW256A008KIA	7.5	100	1.0	2.0	−40	10.5	12	820
56	A	40AW566A008KIA	14.0	59	1.0	2.0	−40	14	16	900
120	B	40AW127B008KIA	20.0	50	1.0	2.0	−44	17.5	20	1220
220	B	40AW227B008KIA	37.0	30	1.0	7.0	−44	17.5	20	1370
290	C	40AW297C008KIA	34.0	25	2.0	6.0	−64	17.5	20	1770
430	C	40AW437C008KIA	46.0	25	2.0	14.0	−64	17.5	20	1825
850	D	40AW857D008KIA	60.0	22	4.0	16.0	−80	25	25	2330
		10 VOLTS D-C AT 85°C, 7 VOLTS D-C AT 125°C								
20	A	40AW206A010KIA	6.0	175	1.0	2.0	−32	10.5	12	820
47	A	40AW476A010KIA	13.0	100	1.0	2.0	−36	14	16	855
100	B	40AW107B010KIA	15.0	60	1.0	4.0	−36	14	16	1200
180	B	40AW187B010KIA	30.0	40	1.0	7.0	−36	14	16	1365
250	C	40AW257C010KIA	30.0	30	2.0	10.0	−40	14	16	1720
390	C	40AW397C010KIA	44.0	25	2.0	16.0	−64	17.5	20	1800
750	D	40AW757D010KIA	50.0	23	4.0	16.0	−80	25	25	2360
		15 VOLTS D-C AT 85°C, 10 VOLTS D-C AT 125°C								
15	A	40AW156A015KIA	5.0	155	1.0	2.0	−24	10.5	12	780
33	A	40AW336A015KIA	10.0	90	1.0	2.0	−28	14	16	820
70	B	40AW706B015KIA	13.0	75	1.0	4.0	−28	14	16	1150
120	B	40AW127B015KIA	18.0	50	1.0	7.0	−28	17.5	20	1450
170	C	40AW177C015KIA	25.0	35	2.0	10.0	−32	14	16	1480
270	C	40AW277C015KIA	32.0	30	2.0	16.0	−56	17.5	20	1740
540	D	40AW547D015KIA	40.0	23	6.0	24.0	−80	25	25	2300
		25 VOLTS D-C AT 85°C, 15 VOLTS D-C AT 125°C								
10	A	40AW106A025KIA	4.0	220	1.0	2.0	−16	8	9	715
22	A	40AW226A025KIA	6.6	140	1.0	2.0	−20	10.5	12	825
50	B	40AW506B025KIA	11.0	70	1.0	2.0	−28	13	15	1130
100	B	40AW107B025KIA	15.0	50	1.0	10.0	−28	13	15	1435
120	C	40AW127C025KIA	21.0	38	2.0	6.0	−32	13	15	1450
180	C	40AW187C025KIA	26.0	32	2.0	18.0	−48	13	15	1525
350	D	40AW357D025KIA	35.0	24	7.0	28.0	−70	25	25	1970

SERIES 40AW

Industrial Type Tantalum Capacitors

μF	Case Code	Catalog Number *	Max. DF at 25°C and 120 Hz %	Max. Impedance at −55°C and 120 Hz (Ω)	Max. D-C Leakage Current at 25°C (μA)	Max. D-C Leakage Current at 85°C & 125°C (μA)	Maximum Capacitance Change in Percent at −55°C	Maximum Capacitance Change in Percent at +85°C	Maximum Capacitance Change in Percent at +125°C	Max. RMS Ripple Current At 40 KHz (mA)
30 VOLTS D-C AT 85°C, 20 VOLTS D-C AT 125°C										
8	A	40AW805A030KIA	4.0	275	1.0	2.0	−16	8	12	640
15	A	40AW156A030KIA	5.0	175	1.0	2.0	−20	10.5	12	780
40	B	40AW406B030KIA	10.0	65	1.0	5.0	−24	10.5	12	1120
68	B	40AW686B030KIA	13.0	60	1.0	8.0	−24	13	15	1285
100	C	40AW107C030KIA	17.0	40	2.0	12.0	−28	10.5	12	1450
150	C	40AW157C030KIA	23.0	35	2.0	18.0	−48	13	15	1525
300	D	40AW307D030KIA	31.0	25	8.0	32.0	−60	25	25	1950
50 VOLTS D-C AT 85°C, 30 VOLTS D-C AT 125°C										
5	A	40AW505A050KIA	3.0	400	1.0	2.0	−16	5	6	580
10	A	40AW106A050KIA	4.0	250	1.0	2.0	−24	8	9	715
25	B	40AW256B050KIA	8.0	95	1.0	5.0	−20	10.5	12	1005
47	B	40AW476B050KIA	11.0	70	1.0	9.0	−28	13	15	1155
60	C	40AW606C050KIA	12.0	45	2.0	12.0	−16	10.5	12	1335
82	C	40AW826C050KIA	15.0	45	2.0	16.0	−32	13	15	1400
160	D	40AW167D050KIA	17.0	27	8.0	32.0	−50	25	25	1900
60 VOLTS D-C AT 85°C, 40 VOLTS D-C AT 125°C										
4	A	40AW405A060KIA	2.8	550	1.0	2.0	−16	5	6	525
8.2	A	40AW825A060KIA	4.0	275	1.0	2.0	−24	8	9	625
20	B	40AW206B060KIA	7.0	105	1.0	5.0	−16	10.5	12.0	930
39	B	40AW396B060KIA	10.0	90	1.0	9.0	−28	10.5	15	1110
50	C	40AW506C060KIA	10.0	50	2.0	12.0	−16	10.5	12	1330
68	C	40AW686C060KIA	13.0	50	2.0	16.0	−32	10.5	12.0	1365
140	D	40AW147D060KIA	16.0	28	8.0	32.0	−40	20	20	1850
75 VOLTS D-C at 85°C, 50 VOLTS D-C AT 125°C										
3.5	A	40AW355A075KIA	2.5	650	1.0	2.0	−16	5	6	525
6.8	A	40AW685A075KIA	3.5	300	1.0	2.0	−20	8	9	610
15	B	40AW156B075KIA	6	150	1.0	5.0	−16	8	9	890
33	B	40AW336B075KIA	10	90	1.0	10.0	−24	10.5	15	1000
40	C	40AW406C075KIA	9	60	2.0	12.0	−16	10.5	12	1250
56	C	40AW566C075KIA	11	60	2.0	17.0	−28	10.5	15	1335
110	D	40AW117D075KIA	12	29	9.0	36.0	−35	20	20	1850
100 VOLTS D-C AT 85°C, 65 VOLTS D-C AT 125°C										
2.5	A	40AW255A100KIA	2.0	950	1.0	2.0	−16	7	8	505
4.7	A	40AW475A100KIA	3.0	500	1.0	2.0	−16	7	8	565
11	B	40AW116B100KIA	5.0	200	1.0	4.0	−16	8	8	835
22	B	40AW226B100KIA	7.5	100	1.0	9.0	−16	8	8	965
30	C	40AW306C100KIA	7.0	80	2.0	12.0	−16	8	8	1240
43	C	40AW436C100KIA	8.5	70	2.0	17.0	−20	8	8	1335
86	D	40AW866D100KIA	10.0	30	9.0	36.0	−25	15	15	1800
125 VOLTS D-C AT 85°C, 85 VOLTS D-C AT 125°C										
1.7	A	40AW175A125KIA	2.0	1250	1.0	2.0	−16	7	8	415
3.6	A	40AW365A125KIA	2.7	600	1.0	2.0	−16	7	8	520
9	B	40AW905B125KIA	5.0	240	1.0	5.0	−16	7	8	755
14	B	40AW146B125KIA	6.0	167	1.0	7.0	−16	7	8	860
18	C	40AW186C125KIA	5.0	129	2.0	9.0	−16	7	8	1130
25	C	40AW256C125KIA	6.0	93	2.0	13.0	−16	7	8	1200
56	D	40AW566D125KIA	6.5	32	10.0	40.0	−25	15	15	1800

*Catalog numbers listed are for 2=10% capacitance tolerance and are for insulated capacitors.

PERFORMANCE CHARACTERISTICS

1. Operating Temperature Range. These capacitors are designed to operate over a temperature range of −55°C to +125°C at the appropriate voltage rating given in Para. 17.

2. DC Working Voltage. The dc working voltage is the maximum operating voltage for continuous duty at the rated temperature.

Up to 85°C	125°C
6	4
8	5
10	7
15	10
25	15
30	20
50	30
60	40
75	50
100	65
125	85

3. DC Leakage Current. Measurements shall be made at the applicable rated working voltage at 25°C ±5°C through application of a steady source of power, such as a regulated power supply. A current limiting resistor of 1000 ohms shall be connected in series with each capacitor under test. Rated DC working voltage shall be applied for a maximum period of 5 minutes before making leaking current measurements.

3.1 The maximum leakage current values are as listed in the standard ratings table.

4. Capacitance and Tolerance. The capacitance of all capacitors shall be within the specified tolerance limits of the nominal rating.

4.1 Measurements shall be made by the bridge method at or referred to a frequency of 120 Hz at a temperature of +25°C. The maximum voltage applied to the capacitors during measurements shall be 1 volt rms. Measurement accuracy of the bridge shall be within ±2%.

5. Dissipation Factor. Measurements are made with a polarized capacitance bridge at a frequency of 120 Hz at a temperature of +25°C.

6. Capacitance Change with Temperature. Capacitance change with temperature shall not exceed the limits given in the standard ratings table.

7. Low Temperature Impedance. The impedance of any capacitor at −55°C at 120 Hz shall not exceed the values given in the standard ratings table.

8. Mechanical Shock. Capacitors shall withstand a shock of 100g when tested in accordance with method 213 of MIL-STD-202, test condition I.

8.1 Following the shock test, capacitors shall be examined for evidence of mechanical damage and leakage of electrolyte.

9. High Frequency Vibration. Capacitors shall withstand vibration from 10 to 2000 Hz at 20g without internal damage when tested in accordance with MIL-STD-202, method 204, test condition D. Electrical measurements made while under these conditions shall show no intermittent contacts or open or short circuiting.

9.1 Following the vibration test, the dc leakage current shall not exceed 125% of the original requirement; the capacitance shall change not more than ±5% from the initial measured value and the DF shall not exceed 115% of initial requirement.

9.2 In addition, there shall be no evidence of mechanical damage, obliteration of marking, or leakage of electrolyte.

10. Pull Test. Leads shall withstand a tensile stress of 3 lbs. for 30 seconds applied axially in accordance with MIL-STD-202, method 211A, test condition A.

11. Lead Bend Test. Leads shall meet the bend test specified in MIL-STD-202, method 211A, test condition C except that the number of bends shall be 4.

12. Surge Voltage. The surge voltage rating is the maximum voltage to which the capacitors shall be subjected under any conditions. This includes transients and peak ripple at the highest line voltage. The surge voltage of these capacitors is 115% of rated dc working voltage.

12.1 The capacitors shall withstand the surge voltage applied through a 1000 ohm ±10% resistor in series with the capacitor and voltage source at the rate of ½ minute on, 5½ minutes off, for 1000 successive test cycles at 85°C.

12.2 Following the surge voltage test, there shall be no intermittent contacts, open or short circuiting, mechanical damage, or leakage of electrolyte.

13. Moisture Resistance. Capacitors shall be subjected to the moisture resistance cycling test specified in MIL-STD-202, method 106.

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Industrial Type Tantalum Capacitors

PERFORMANCE CHARACTERISTICS

13.1 Following the moisture resistance test, the dc leakage current shall not exceed 125% of the original requirement; the capacitance shall change not more than ±8% from the initial measured value and the DF shall not exceed 115% of initial requirement.

14. Seal Test. Capacitors shall be tested in accordance with MIL-STD-202, method 112, test condition C, procedure IIIa, 10^{-8} atm cc/sec followed by test condition A.

15. Reverse Voltage Test. Capacitors shall be subjected to a dc potential of 3 volts, applied in the reverse polarity direction, for 125 ±10 hours. The ambient temperature during the test shall be +85°C. Capacitors shall be maintained at +85°C and dc rated voltage shall be applied in the forward direction for an additional period of 125 ±10 hours.

15.1 Following the reverse voltage testing, the dc leakage current shall not exceed 125% of the original requirement; the capacitance shall be within the initial value specified and the DF shall not exceed the original requirements.

16. Ripple Life Test at +85°C. Capacitors shall be tested in accordance with MIL-C-39006. a. Operating Conditions. This test shall be run at a frequency of 40 KHz ±2 KHz and at the rms ripple current levels specified in the standard ratings table. b. Applied dc voltage plus the peak a-c voltage shall not exceed the rated voltage of the capacitor.

16.1 When tested as specified above, capacitors shall meet the following requirements: a. The dc leakage current at 25°C and at 85°C shall not exceed the original requirements. b. The capacitance shall not change more than ±10% from the initial measured value. c. The DF shall not exceed the original requirements. d. Visual examination. There shall be no damage, obliteration of marking, or leakage of electrolyte.

17. Life Test. Capacitors are capable of withstanding life test at the following conditions:

Temperature	Hrs.	% Rated Voltage
+85°C	2000	100*
+125°C	2000	100*

*Refer to the standard ratings table.

17.1 After life test and for those tested at +85 and/or +125°C, shall not exceed the initial requirement; the DF shall not exceed the initial requirement; and the capacitance value shall not change more than 10% from the initial measurement.

18. Barometric Pressure (reduced). Capacitors shall be tested in accordance with MIL-STD-202, method 105, test condition E. Rated dc voltage shall be applied for 1 minute ±5 seconds.

18.1 Following Barometric Pressure test, capacitors shall be visually examined for harmful deformation of the case, mechanical damage, obliteration of marking, leakage of electrolyte and indications of flashover and breakdown.

19. Thermal Shock. Capacitors shall be subjected to 300 cycles in accordance with MIL-STD-202, method 107 and MIL-C-39006.

19.1 Following the thermal shock test, dc leakage current shall not exceed 200% of the initial requirement, capacitance shall not have changed more than ±5% from initial measured value and DF shall not exceed 115% of initial specified value.

20. Marking. Capacitors shall be marked with Philips Components part marking, type number (40AW), rated capacitance and tolerance, rated dc working voltage and the standard EIA date code of manufacture.

21. Polarity. Polarity shall be indicated by plus (+) signs adjacent to the positive terminal.

22. Insulation. When an insulated device is required, the insulating material will be MYLAR.

RIPPLE CURRENT MULTIPLIERS VS. FREQUENCY, TEMPERATURE & APPLIED PEAK VOLTAGE

	Frequency of applied ripple current	120 Hz Temp °C				800 Hz Temp °C				1 kHz Temp °C				10 kHz Temp °C				40 kHz Temp °C				100 kHz Temp °C			
	Ambient still air	≤55°	85°	105°	125°	≤55°	85°	105°	125°	≤55°	85°	105°	125°	≤55°	85°	105°	125°	≤55°	85°	105°	125°	≤55°	85°	105°	125°
% of 85°C rated peak voltage	100%	.60	.39	—	—	.71	.43	—	—	.72	.45	—	—	.88	.55	—	—	1.0	63	—	—	1.1	.69	—	—
	90%	.60	.46	—	—	.71	.55	—	—	.72	.55	—	—	.88	.67	—	—	1.0	.77	—	—	1.1	.85	—	—
	80%	.60	.52	.35	—	.71	.62	.42	—	.72	.62	.42	—	.88	.76	.52	—	1.0	.87	.59	—	1.1	.96	.65	—
	70%	.60	58	.44	—	.71	.69	.52	—	.72	.70	.52	—	.88	.85	.64	--	1.0	.97	.73	—	1.1	1.07	.80	—
	≤66-2/3%	.60	.60	.46	.27	.71	.71	.55	.32	.72	.72	.55	32	.88	.88	.68	.40	1.0	1.0	77	.45	1.1	1.1	.85	50

NOTES:

1. At 125°C the rated voltage of the capacitors decreases to 66-2/3% of the 85°C rated voltage
2. The peak of the applied ac ripple voltage plus the applied dc voltage must not exceed the dc voltage rating of the capacitor either forward or reverse
3. The ripple current listed in table I represents a rating calculated using a maximum internal temperature rise (△T) of 50°C at 40 kHz at 85°C ambient with a maximum peak rated voltage of 66-2/3% of the 85°C peak voltage rating.
4. The maximum allowable internal temperature rise (△T) decreases linearly to a calculated 10°C rise at 125°C ambient.
5. The internal temperature rise is directly proprotional to the ESR of the capacitor, and ESR increases with decreasing frequency

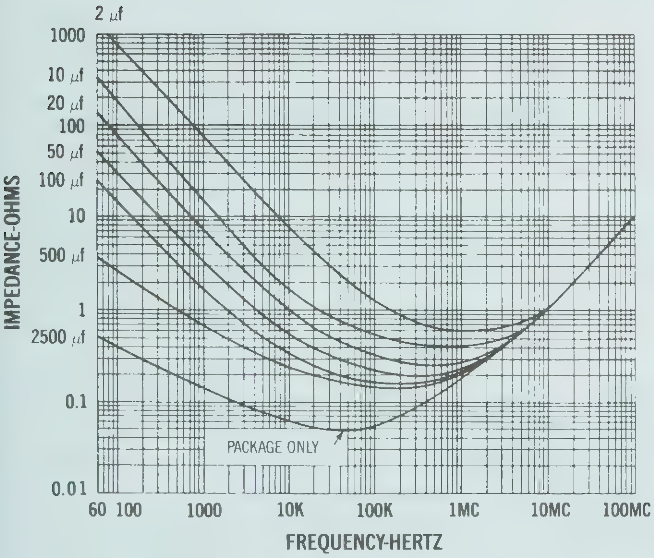
TYPICAL CURVES

Impedance

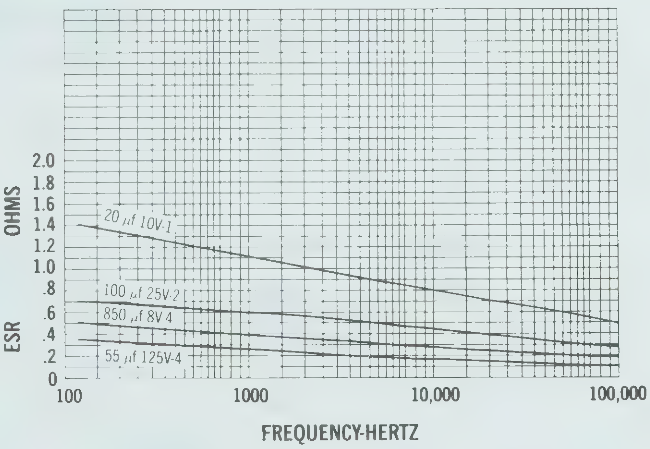
A. Impedance in ohms at 25° C may be read directly from Curve 1.

B. To obtain impedance at temperatures other than 25° C, multiply the impedance from Curve 5 by a correction factor from Curve 2, 3, or 4.

IMPEDANCE FOR TANTALUM WET SLUGS AT 25°C NO. 1



TYPICAL ESR VS. FREQUENCY AT 25°C



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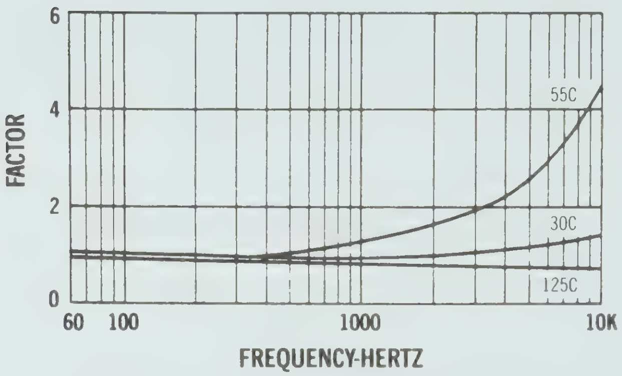
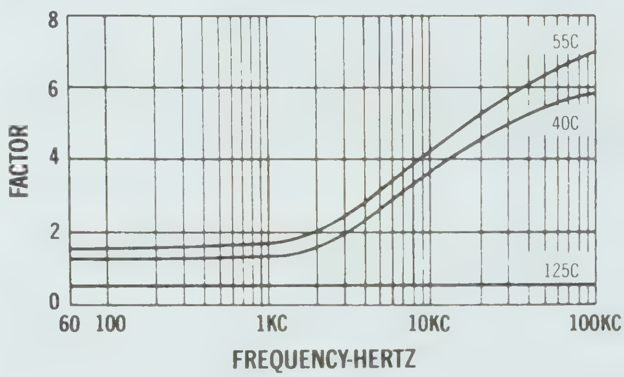
Industrial Type Tantalum Capacitors

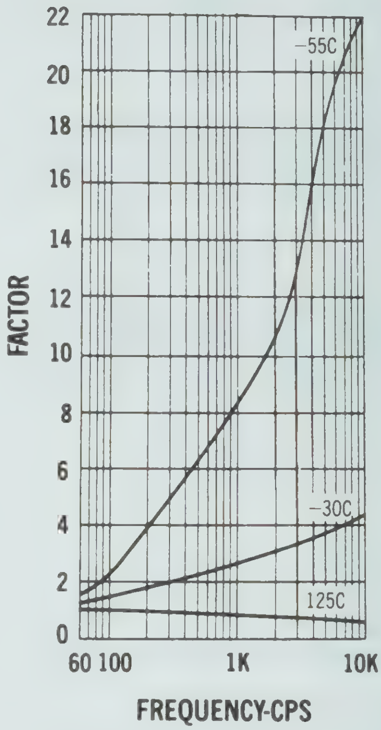
WET SLUG IMPEDANCE CORRECTION FACTORS
UP TO 5 μf
NO. 2



WET SLUG IMPEDANCE CORRECTION FACTORS
FOR CAPACITANCE 5-100 μf
NO. 3



WET SLUG IMPEDANCE CORRECTION FACTORS
FOR CAPACITANCE 100 μf
AND ABOVE INCLUDING PACKAGES
NO. 4



HOW TO SPECIFY

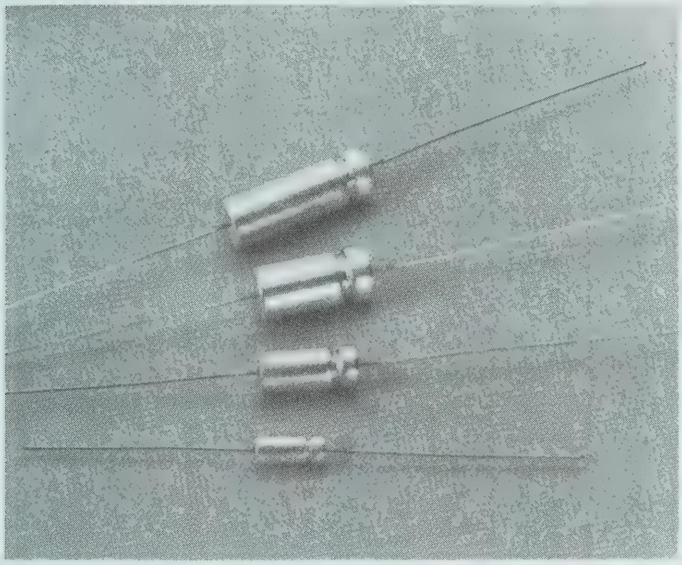
Series 40AW can be specified using the following designation:

Code	Meaning
4	Tantalum Capacitor
0	Axial Lead
A	Series
W	Wet Slug
225	**Capacitance in (pF)** First two digits are significant figures. Third digit numbers of zeros to follow 225 = 2.2μF 226 = 22μF
A	Case Size
075	**Voltage Rating @ 85°C**
K	**Capacitance Tolerance** J = ±5% K = ±10% M = ±20%
I	O = Unsleeved I = Sleeved
A	Industrial

SERIES 40BW

CLR 81

Extended Range Tantalum Case Hermetically Sealed Tubular Tantalum-Case Wet-Slug Capacitor



−55°C to 125°C 6.8 to 1800 μF
4-125 Volts DC

3

Tantalum Capacitors

DESCRIPTION

The 40BW capacitor is an extended range all tantalum cased high reliability porous anode type with a glass to tantalum hermetic seal. This type capacitor is primarily suited for military and aerospace application. This capacitor meets or exceeds all requirements of MIL-C-39006/25.

These capacitors are ideal for such functions as filtering, by-passing, coupling and timing in applications where minimum size and weight conditions must be achieved and reverse voltage up to 3VDC, or high ripple currents, are required.

GLASS-TO-TANTALUM SEAL

The glass-to-tantalum seal is one unique feature of the 40BW Series. This seal differs from other hermetic seals in that it is a tantalum feed-through seal. This construction (Fig.1) provides a true glass-to-tantalum seal.

TANTALUM CASE

Use of a tantalum case and tantalum powder cathode permits 3VDC reverse capability without harm; and the sintered powder cathode allows higher vibration and shock levels than comparable silver cased devices.

FEATURES

- Extended Range
- All tantalum construction
- Reverse voltage capability of 3VDC
- High ripple current
- Long life
- Rated for −55ºC to 125ºC Operation

WARNING
NON-SOLID ELECTROLYTIC CAPACITORS MAY CONTAIN CHEMICALS WHICH CAN BE REGARDED AS HAZARDOUS IF HANDLED INCORRECTLY. CAUTION IS NECESSARY IF THE OUTER CASE IS FRACTURED.

SERIES 40BW

Tubular Tantalum-Case Wet Slug Capacitor

DIMENSIONS OUTLINE DRAWING

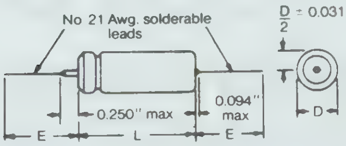


FIG. 1 UNINSULATED

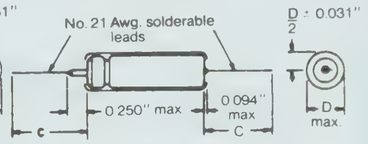


FIG.2 INSULATED

OUTLINE DIMENSIONS

Case Code		Dimensions — Inches (mm)					
		Basic Case		Insulated Case			
Type 40BW	MIL Equiv.	L +.031 (.79) −.016 (.41)	D ±.016 (.41)	D max	E ±.250 (6.35)	d ±.002 (.05)	Approximate Weight (Grams)
A	T1	.453 (11.51)	.188 (4.78)	.219 (5.56)	1.500 (38.10)	.025 (.64)	2.0
B	T2	.641 (16.28)	.281 (7.14)	.312 (7.92)	2.250 (57.15)	.025 (.64)	5.1
C	T3	.766 (19.48)	.375 (9.53)	.406 (10.31)	2.250 (57.15)	.025 (.64)	9.0
D	T4	1.062 (26.97)	.375 (9.53)	.406 (10.31)	2.250 (57.15)	.025 (.64)	14.5

Length of basic case sleeving shall lap over the ends of the capacitor body. Non-shrinkable sleeving extends .016 inch minimum, .062 inch maximum beyond each end of the case.

STANDARD RATINGS

Philips Components Part Number	Cap @ 25°C & 120 Hz μF	Cap Tol ± %	Max ESR @ 25°C & 120 Hz ohms	Max DCL μA 25°C	Max DCL μA 85°C & 125°C	AC ripple 85°C 40 kHz mA rms	Max D.F. @ 120Hz %	Max Imp @−55°C & 120Hz ohms	Case Size
4 VDC @ 125°C									
40BW227A006M1*	220	20	3.02	2	9	1000	50	36	T1
40BW227A006K1*	220	10	3.02	2	9	1000	50	36	T1
40BW827B006M1*	820	20	2.51	3	14	1500	155	18	T2
40BW827B006K1*	820	10	2.51	3	14	1500	155	18	T2
40BW158C006M1*	1500	20	1.52	5	20	1900	172	18	T3
40BW158C006K1*	1500	10	1.52	5	20	1900	172	18	T3
40BW228D006M1*	2200	20	1.03	6	24	2300	170	13	T4
40BW228D006K1*	2200	10	1.03	6	24	2300	170	13	T4
5 VDC @ 125°C									
40BW187A008M1*	180	20	3.03	2	9	1000	41	45	T1
40BW187A008K1*	180	10	3.03	2	9	1000	41	45	T1
40BW687B008M1*	680	20	2.54	3	14	1500	130	22	T2
40BW687B008K1*	680	10	2.54	3	14	1500	130	22	T2
40BW158C008M1*	1500	20	1.51	5	20	1900	170	18	T3
40BW158C008K1*	1500	10	1.51	5	20	1900	170	18	T3
40BW188D008M1*	1800	20	1.02	7	25	2300	138	14	T4
40BW188D008K1*	1800	10	1.02	7	25	2300	138	14	T4
7 VDC @ 125°C									
40BW157A010M1*	150	20	3.01	2	9	900	34	54	T1
40BW157A010K1*	150	10	3.01	2	9	900	34	54	T1
40BW567B010M1*	560	20	2.52	3	16	1450	106	27	T2
40BW567B010K1*	560	10	2.52	3	16	1450	106	27	T2
40BW128C010M1*	1200	20	1.52	5	20	1850	137	18	T3
40BW128C010K1*	1200	10	1.52	5	20	1850	137	18	T3
40BW158D010M1*	1500	20	1.01	7	25	2300	114	15	T4
40BW158D010K1*	1500	10	1.01	7	25	2300	114	15	T4
10 VDC @ 125°C									
40BW107A015M1*	100	20	3.99	2	9	900	30	72	T1
40BW107A015K1*	100	10	3.99	2	9	900	30	72	T1
40BW397B015M1*	390	20	2.52	3	16	1450	74	31	T2
40BW397B015K1*	390	10	2.52	3	16	1450	74	31	T2
40BW827C015M1*	820	20	1.80	6	24	1800	111	22	T3
40BW827C015K1*	820	10	1.80	6	24	1800	111	22	T3
40BW108D015M1*	1000	20	1.22	8	32	2300	92	17	T4
40BW108D015K1*	1000	10	1.22	8	32	2300	92	17	T4
15 VDC @ 125°C									
40BW686A025M1*	68	20	4.30	2	9	850	22	90	T1
40BW686A025K1*	68	10	4.30	2	9	850	22	90	T1
40BW277B025M1*	270	20	2.71	3	16	1400	55	33	T2
40BW277B025K1*	270	10	2.71	3	16	1400	55	33	T2
40BW567C025M1*	560	20	1.80	7	28	1750	76	24	T3
40BW567C025K1*	560	10	1.80	7	28	1750	76	24	T3
40BW687D025M1*	680	20	1.23	8	32	2100	63	19	T4
40BW687D025K1*	680	10	1.23	8	32	2100	63	19	T4

SERIES 40BW

Tubular Tantalum-Case Wet Slug Capacitor

Philips Components Part Number	Cap @ 25°C & 120 Hz µF	Cap Tol ± %	Max ESR @ 25°C & 120 Hz ohms	Max DCL µA 25°C	Max DCL µA 85°C & 125°C	AC ripple 85°C 40 kHz mA rms	Max D.F. @ 120Hz %	Max Imp @−55°C & 120Hz ohms	Case Size
20 VDC @ 125°C									
40BW566A030M1*	56	20	5.22	2	9	800	22	100	T1
40BW566A030K1*	56	10	5.22	2	9	800	22	100	T1
40BW227B030M1*	220	20	2.54	3	16	1200	42	36	T2
40BW227B030K1*	220	10	2.54	3	16	1200	42	36	T2
40BW477C030M1*	470	20	1.81	8	32	1500	64	25	T3
40BW477C030K1*	470	10	1.81	8	32	1500	64	25	T3
40BW567D030M1*	560	20	1.31	9	36	2000	55	20	T4
40BW567D030K1*	560	10	1.31	9	36	2000	55	20	T4
30 VDC @ 125°C									
40BW336A050M1*	33	20	4.96	2	9	700	12.3	135	T1
40BW336A050K1*	33	10	4.96	2	9	700	12.3	135	T1
40BW127B050M1*	120	20	2.49	4	24	1200	22.5	49	T2
40BW127B050K1*	120	10	2.49	4	24	1200	22.5	49	T2
40BW277C050M1*	270	20	1.82	8	32	1450	37	29	T3
40BW277C050K1*	270	10	1.82	8	32	1450	37	29	T3
40BW337D050M1*	330	20	1.53	9	36	1900	38	22	T4
40BW337D050K1*	330	10	1.53	9	36	1900	38	22	T4
40 VDC @ 125°C									
40BW276A060M1*	27	20	5.02	3	12	700	10.2	144	T1
40BW276A060K1*	27	10	5.02	3	12	700	10.2	144	T1
40BW107B060M1*	100	20	2.53	4	20	1100	19	54	T2
40BW107B060K1*	100	10	2.53	4	20	1100	19	54	T2
40BW227C060M1*	220	20	1.81	8	32	1400	30	29	T3
40BW227C060K1*	220	10	1.81	8	32	1400	30	29	T3
40BW277D060M1*	270	20	1.33	9	36	1850	27	23	T4
40BW277D060K1*	270	10	1.33	9	36	1850	27	23	T4
50 VDC @ 125°C									
40BW226A075M1*	22	20	5.14	3	12	600	8.5	157	T1
40BW226A075K1*	22	10	5.14	3	12	600	8.5	157	T1
40BW826B075M1*	82	20	2.46	4	24	1000	15.2	63	T2
40BW826B075K1*	82	10	2.46	4	24	1000	15.2	63	T2
40BW187C075M1*	180	20	1.80	9	36	1300	24.4	30	T3
40BW187C075K1*	180	10	1.80	9	36	1300	24.4	30	T3
40BW227D075M1*	220	20	2.24	10	40	1800	37.0	24	T4
40BW227D075K1*	220	10	2.24	10	40	1800	37.0	24	T4
65 VDC @ 125°C									
40BW106A100M1*	10	20	5.99	3	12	800	4.5	200	T1
40BW106A100K1*	10	10	5.99	3	12	800	4.5	200	T1
40BW396B100M1*	39	20	3.55	5	24	1300	10.4	80	T2
40BW396B100K1*	39	10	3.55	5	24	1300	10.4	80	T2
40BW686C100M1*	68	20	2.21	10	40	1600	11.3	40	T3
40BW686C100K1*	68	10	2.21	10	40	1600	11.3	40	T3
40BW127D100M1*	120	20	2.77	12	48	2000	25	30	T4
40BW127D100K1*	120	10	2.77	12	48	2000	25	30	T4
85 VDC @ 125°C									
40BW685A125M1*	6.8	20	11.7	3	12	700	6.0	300	T1
40BW685A125K1*	6.8	10	11.7	3	12	700	6.0	300	T1
40BW276B125M1*	27	20	3.55	5	24	1200	7.2	90	T2
40BW276B125K1*	27	10	3.55	5	24	1200	7.2	90	T2
40BW476C125M1*	47	20	2.24	10	40	1500	7.9	50	T3
40BW476C125K1*	47	10	2.24	10	40	1500	7.9	50	T3
40BW826D125M1*	82	20	2.82	12	48	1900	17.4	32	T4
40BW826D125K1*	82	10	2.82	12	48	1900	17.4	32	T4

SERIES 40BW

Tubular Tantalum-Case Wet Slug Capacitor

3

Tantalum Capacitors

PERFORMANCE CHARACTERISTICS

1. Operating Temperature Range. These capacitors are designed to operate over a temperature range of −55°C to +85°C and +125°C with proper derating, at the appropriate voltage rating given.

2. DC Working Voltage. The dc working voltage is the maximum operating voltage for continuous duty at the rated temperature.

Up to 85°C	125°C
6	4
8	5
10	7
15	10
25	15
30	20
50	30
60	40
75	50
100	65
125	85

3. DC Leakage Current. Measurements shall be made at the applicable rated working voltage at 25°C±5°C through application of a steady source of power, such as a regulated power supply. A current limiting resistor of 1000 ohms shall be connected in series with each capacitor under test. Rated DC working voltage shall be applied for a maximum period of 5 minutes before making leaking current measurements.

3.1 The maximum leakage current values are as listed in the standard ratings table.

4. Capacitance and Tolerance. The capacitance of all capacitors shall be within the specified tolerance limits of the nominal rating.

4.1 Measurements shall be made by the bridge method at a frequency of 120 Hz at a temperature of +25°C. The maximum voltage applied to the capacitors during measurements shall be 1 volt rms. Measurement accuracy of the bridge shall be within ±2%.

5. Dissipation Factor. Measurements are made with a polarized capacitance bridge at a frequency of 120 Hz at a temperature of +25°C.

6. Low Temperature Impedance. The impedance of any capacitor at −55°C at 120 Hz shall not exceed the values given in the standard ratings table.

7. Mechanical Shock. Capacitors shall withstand a shock of 100g when tested in accordance with method 213 of Military Standard MIL-STD-202, test condition I.

7.1 Following the shock test, capacitors shall be examined for evidence of mechanical damage and leakage of electrolyte.

8. High Frequency Vibration. Capacitors shall withstand vibration from 10 to 2000 Hz at 20g without internal damage when tested in accordance with Military Standard MIL-STD-202, method 204, test condition D. Electrical measurements made while under these conditions shall show no intermittent contacts or open or short circuiting.

8.1 Following the vibration test, the dc leakage current shall not exceed 125% of the original requirement; the capacitance shall change not more than ±5% from the initial measured value and the DF shall not exceed 115% of initial requirement.

8.2 In addition, there shall be no evidence of mechanical damage, obliteration of marking, or leakage of electrolyte.

9. Pull Test. Leads shall withstand a tensile stress of 3 lbs. for 30 seconds applied axially in accordance with MIL-STD-202, method 211, test condition A.

10. Lead Bend Test. Leads shall meet the bend test specified in MIL-STD-202, method 211, test condition B. Except number of bend shall be 4.

11. Surge Voltage. The surge voltage rating is the maximum voltage to which the capacitors shall be subjected under any conditions. This includes transients and peak ripple at the highest line voltage. The surge voltage of these capacitors is 115% of rated dc working voltage.

11.1 The capacitors shall withstand the surge voltage applied through a 1000 ohm ±10% resistor in series with the capacitor and voltage source at the rate of ½ minute on, 5½ minutes off, for 1000 successive test cycles at 85°C.

11.2 Following the surge voltage test, there shall be no intermittent contacts, open or short circuiting, mechanical damage, or leakage of electrolyte.

12. Moisture Resistance. Capacitors shall be subjected to the moisture resistance cycling test specified in MIL-STD-202, method 106.

PERFORMANCE CHARACTERISTICS

12.1 Following the moisture resistance test, the dc leakage current shall not exceed 125% of the original requirement; the capacitance shall change not more than ±8% from the initial measured value and the DF shall not exceed 115% of initial requirement.

13. Seal Test. Capacitors shall be tested in acccordance with MIL-STD-202, method 112, test condition C, procedure IIIa, 10^{-8} atm cc/sec followed by test condition A.

14. Reverse Voltage Test. Capacitors shall be subjected to a dc potential of 3 volts, applied in the reverse polarity direction, for 125±10 hours. The ambient temperature during the test shall be +85°C. Capacitors shall be maintained at +85°C and dc rated voltage shall be applied in the forward direction for an additional period of 125±10 hours.

14.1 Following the reverse voltage testing, the dc leakage current shall not exceed 125% of the original requirement; the capacitance shall be within the initial value specified and the DF shall not exceed the original requirements.

15. Ripple Life Test at +85°C. Capacitors shall be tested in accordance with Military Specifications MIL-C-39006. a. Operating Conditions. This test shall be run at a frequency of 40 KHz ±2 KHz and at the rms ripple current levels specified in the standard ratings table. b. Applied dc voltage plus the peak a-c voltage shall not exceed the rated voltage of the capacitor.

15.1 When tested as specified above, capacitors shall meet the following requirements: a. The dc leakage current at +25°C and at +85°C shall not exceed the original requirements. b. The capacitance shall not change more than ±10% from the initial measured value. c. The DF shall not exceed the original requirements. d. Visual examination. There shall be no damage, obliteration of marking, or leakage of electrolyte.

16. Life Test. Capacitors are capable of withstanding life test at the following conditions:

Temperature	Hrs.	% Rated Voltage
+85°C	2000	100
+125°C	2000	67

16.1 After life test and for those tested at +85 and/or +125°C, the capacitors shall be returned to +25°C ±5°C. The dc leakage current, measured at +25°C, +85 and/or +125°C, shall not exceed the initial requirement; the DF shall not exceed the initial requirement; and the capacitance value shall not change more than 10% from the initial measurement.

Not more than 1 failure shall be permitted in 12 units tested.

17. Barometric Pressure (reduced). Capacitors shall be tested in accordance with MIL-STD-202, method 105, test condition E. Rated dc voltage shall be applied for 1 minute ±5 seconds.

17.1 Following Barometric Pressure test, capacitors shall be visually examined for harmful deformation of the case, mechanical damage, obliteration of marking, leakage of electrolyte and indications of flashover and breakdown.

18. Thermal Shock. Capacitors shall be subjected to 300 cycles in accordance with MIL-STD-202, method 107 and MIL-C-39006.

18.1 Following the thermal shock test, dc leakage current shall not exceed 200% of the initial requirement, capacitance shall not have changed more than ±5% from initial measured value and DF shall not exceed 115% of initial specified value.

19. Marking. Capacitors shall be marked with Philips Components part marking, type number (40BW), rated capacitance and tolerance, rated dc working voltage at +85°C and the standard EIA date code of manufacture.

19.1 Military devices will be marked as specified in MIL-C-39006. Para. 3.32.

20. Polarity. Polarity shall be indicated by plus (+) signs adjacent to the positive terminal.

21. Insulation. When an insulated device is required, the insulating material will be mylar.

SERIES 40BW

Tubular Tantalum-Case Wet Slug Capacitor

RIPPLE CURRENT MULTIPLIERS VS. FREQUENCY, TEMPERATURE & APPLIED PEAK VOLTAGE

Frequency of applied ripple current		120 Hz				800 Hz				1 kHz				10 kHz				40 kHz				100 kHz			
Ambient still air temperature in °C		−55	85	105	125	−55	85	105	125	−55	85	105	125	−55	85	105	125	−55	85	105	125	−55	85	105	125
85°C rated peak voltage	100%	.60	.39	—	—	.71	.43	—	—	.72	.45	—	—	.88	.55	—	—	1.0	.63	—	—	1.1	.69	—	—
	90%	.60	.46	—	—	.71	.55	—	—	.72	.55	—	—	.88	.67	—	—	1.0	.77	—	—	1.1	.85	—	—
	80%	.60	.52	.35	—	.71	.62	.42	—	.72	.62	.42	—	.88	.76	.52	—	1.0	.87	.59	—	1.1	.96	.65	—
	70%	.60	.58	.44	—	.71	.69	.52	—	.72	.70	.52	—	.88	.85	.64	—	1.0	.97	.73	—	1.1	1.07	.80	—
	66⅔%	.60	.60	.46	.27	.71	.71	.55	.32	.72	.72	.55	.32	.88	.88	.68	.40	1.0	1.0	.77	.45	1.1	1.1	.85	.50

NOTES:

1. At 125°C the rated voltage of the capacitors decreases to 66⅔% of the 85°C rated voltage.
2. The peak of the applied ac ripple voltage plus the applied dc voltage must not exceed the dc voltage rating of the capacitor either forwa or reverse.
3. The ripple current listed in table 1 represents a rating calculated using a maximum internal temperature rise (ΔT) of 50°C at 40 k at 85°C ambient with a maximum peak rated voltage of 66⅔% of the 85°C peak voltage rating.
4. The maximum allowable internal temperature rise (ΔT) decreases nearly to a calculated 10°C rise at 125°C ambient.
5. The internal temperature rise is directly proportional to the ESR of the capacitor and ESR increases with decreasing frequency.

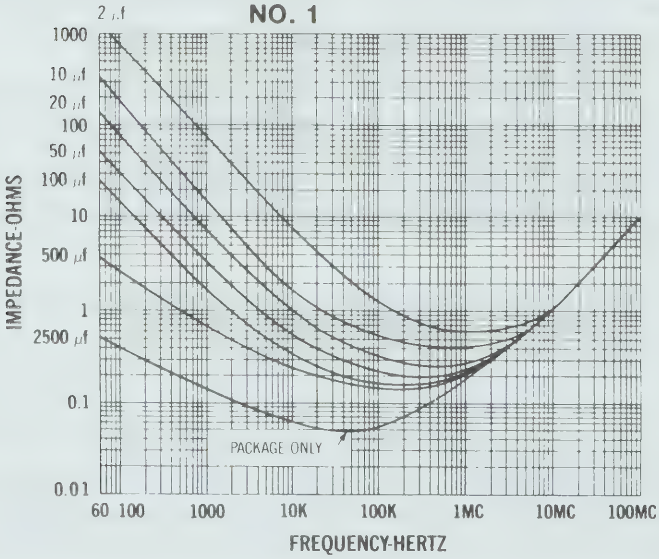
TYPICAL CURVES

Impedance

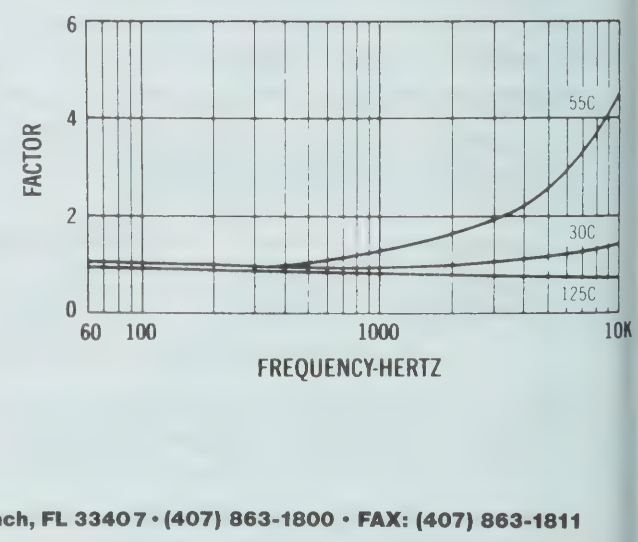
A. Impedance in ohms at 25°C may be read directly from Curve 1.

B. To obtain impedance at temperatures other than 25°C, multiply the impedance from Curve 5 by a correction factor from Curve 2, 3, or 4.

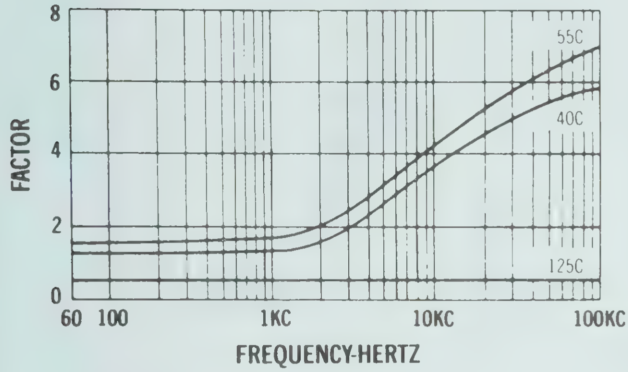
IMPEDANCE FOR TANTALUM WET SLUGS at 25°C NO. 1



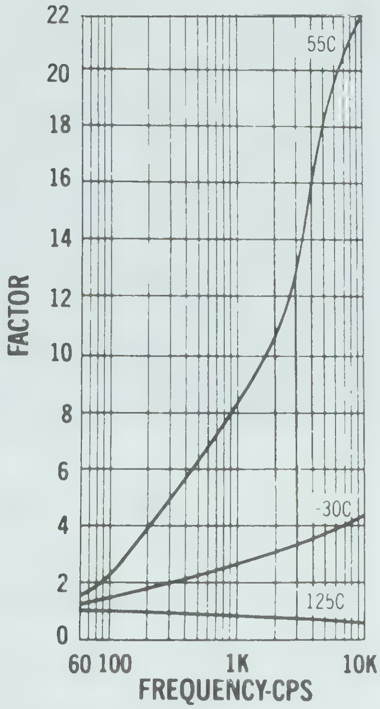
WET SLUG IMPEDANCE CORRECTION FACTORS UP TO 5 µf NO. 2



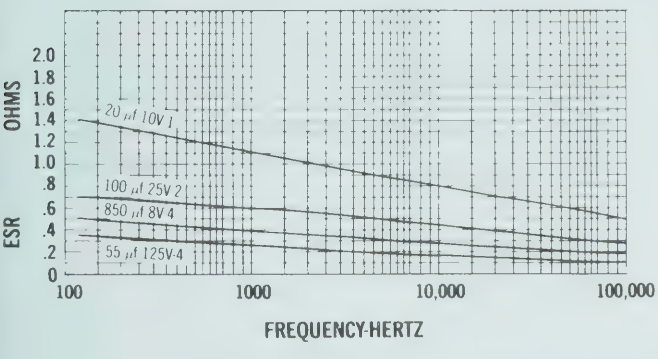
WET SLUG IMPEDANCE CORRECTION FACTORS
FOR CAPACITANCE 5-100 μf
NO. 3



WET SLUG IMPEDANCE CORRECTION FACTORS
FOR CAPACITANCE 100 μf
AND ABOVE INCLUDING PACKAGES
NO.4



TYPICAL ESR VS. FREQUENCY AT 25°C



SERIES 40BW

Tubular Tantalum-Case Wet Slug Capacitor

HOW TO SPECIFY

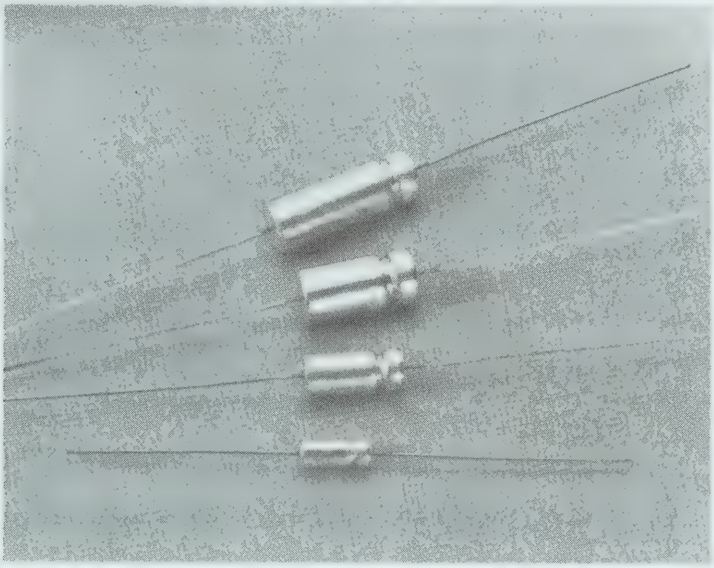
Philips Components Series 40BW can be specified using the following designation:

4 0 B W 226 A 075 K I A

- **4** — Tantalum Capacitor
- **0** — Axial Lead
- **B** — Series
- **W** — Wet Slug
- **226** — Capacitance in (pF)
  First two digits are significant figures.
  Third digit numbers of zeros to follow
  226 = 22uF
  227 = 220 uF
- **A** — Case Size
- **075** — Voltage Rating @85ºC
- **K** — Capacitance Tolerance
  J = ±5%
  K = ±10%
  M = ±20%
- **I** — 0 = Unsleeved
  I = Sleeved
- **A** — Reliability Level
  A = Industrial Grade
  M = CLR81 "M" Level
  P = CLR81 "P" Level
  X = Requires M/C Internal Spec.

SERIES 40EW

Extended Range Tubular Wet Tantalum Capacitor



3

Tantalum Capacitors

DESCRIPTION

40EW Type Tantalum Capacitors are uniquely designed for 125°C applications with a leak proof construction that surpasses all military specifications. The Philips Components 40EW Type capacitor offers extreme savings in both weight and space as compared with the conventional flange type construction. Savings up to 30% in weight and 40% in volume are available.

Philips Components research and development facilities, coupled with years of manufacturing experience, have resulted in these advantages, together with extremely low leakage current. These capacitors are normally supplied with an insulated case, without additional cost, for added protection in compact circuits.

FEATURES

- EXTENDED RANGE
- TUBULAR-POLAR
- THIXOTROPIC ELECTROLYTE
- SINTERED ANODE
- TANTALUM CAPACITOR
- +125°C OPERATION
- ELASTOMER SEAL
- HIGHEST CAPACITANCE PER UNIT VOLUME

WARNING

NON-SOLID ELECTROLYTIC CAPACITORS MAY CONTAIN CHEMICALS WHICH CAN BE REGARDED AS HAZARDOUS IF HANDLED INCORRECTLY. CAUTION IS NECESSARY IF THE OUTER CASE IS FRACTURED.

SERIES 40EW

Industrial Type Tantalum Capacitors

OPERATING TEMPERATURE RANGE

Philips Components 40EW Type Tantalum Capacitors are designed to operate over a temperature range of −55°C to +85°C without derating. The units must be derated @ 125°C.

DC WORKING VOLTAGE

The dc working voltage is the maximum operating voltage for continuous duty at the rated temperature.

SURGE VOLTAGE

The surge dc rating is the maximum voltage to which the capacitors should be subjected under any conditions. This includes transients and peak ripple at the highest line voltage. The surge voltage of all 40EW Type Tantalum Capacitors is 115% of rated dc working voltage.

The capacitors shall withstand the surge test voltage applied through a 1000 ohm ±10% resistor in series with the capacitor and voltage source at the rate of ½ minute on, 5½ minutes off, for 1000 successive test cycles at 125°C.

Following the surge test, the capacitance at 25°C shall not have changed by more than ±10%, the equivalent series resistance will not exceed the value shown in the tables for each capacitor, and the leakage current will not exceed the requirements of paragraph 7. Not more than 1 failure for any of the above reasons shall be allowed for any 12 samples tested.

CAPACITANCE

Capacitance measurements shall be made at or referred to 120 Hz and a temperature of +25°C.

The capacitance of all capacitors shall be within the specified tolerance limits of the nominal rating.

CAPACITANCE CHANGE WITH TEMPERATURE

Capacitance change with temperature shall not exceed the limits given in the tables for each capacitor.

DISSIPATION FACTOR

Measurements shall be made by the bridge method at or referred to a frequency of 120 Hz at a temperature of +25°C.

The Dissipation Factor shall not exceed the maximum value in percent listed in the tables for each capacitor.

LEAKAGE CURRENT

Measurements shall be made at rated working voltage with an application of a steady source of power, such as a regulated power supply with a 1000 ohm resistance to limit the charging current, connected in series with each capacitor under test. Rated working voltage shall be applied to capacitors for 5 minutes before making leakage current measurements.

The maximum leakage current for any capacitor shall not exceed the maximum value in microamperes listed in the tables.

LOW TEMPERATURE IMPEDANCE

The impedance of any capacitor, at −55°C and 120 Hz, shall not exceed the values given in the tables for each capacitor

LIFE TEST

Capacitors are capable of withstanding a 2000 hour life test at a temperature of 125°C at rated dc working voltage.

After life test, the leakage current shall not be in excess of the original requirements, the equivalent series resistance shall not be more than 130% of the initial requirement, and the capacitance value shall not have increased by more than 25% or decreased by more than 15% from the initial value.

Not more than 1 failure shall be permitted in 12 units tested.

LOW FREQUENCY VIBRATION

Capacitors shall withstand a simple harmonic motion having an amplitude of 0.03″ (max. total excursion 0.06″) with the frequency being varied uniformly between the approximate limits of 10 to 55 Hz and ratings to be transversed in approximately 1 minute for a total of 1½ hours.

After vibration test, capacitors shall meet the original requirements for capacitance tolerance, equivalent series resistance, and leakage current.

HIGH FREQUENCY VIBRATION

Capacitors shall withstand vibration from 10 to 2000 Hz at 15g without internal damage. Electrical measurements made while under these conditions shall show no intermittent open or short circuit.

Capacitors shall be securely fastened by means of suitable component clips or brackets.

PULL TEST

Leads shall withstand a tensile stress of 3 lbs. for 30 seconds applied axially.

LEAD BEND TEST

Leads shall meet the bend test described in MIL-C-39006.

MOISTURE RESISTANCE

Capacitors shall withstand the moisture resistance cycling test specified in MIL Standard 202C, method 106A, without departure from the original limits of capacitance, equivalent series resistance, and leakage current.

SHELF TEST

Capacitors shall withstand a 2000 hour shelf test at 125°C with no voltage applied.

Following the shelf test, the capacitance shall not have changed by more than ± 10% from the initial value and the leakage current and equivalent series resistance shall not exceed the values given in the tables for each capacitor.

THERMAL SHOCK

Capacitors shall be tested in accordance with method 107 of MIL-STD-202. The following details and exception shall apply:

(a) Conditioning prior to first cycle—15 minutes at room ambient conditions.
(b) Test condition letter—B.
(c) Measurements before and after cycling—Not applicable.

REDUCED PRESSURE

Capacitors shall be stabilized at a reduced atmospheric pressure of $1.69X10^{-1}$ Torr. for a period of 5 minutes. Rated dc voltage shall be applied for 1 minute. Capacitors shall not flash over nor shall end seals be damaged by this test nor should the capacitors be electrically effected insofar as capacitance, equivalent series resistance, or leakage current is concerned.

MARKING

Capacitors will be marked with Philips Components part marking type (CW), rated capacitance and tolerance, rated DC voltage and date code where space permits.

PART NUMBER SYSTEM

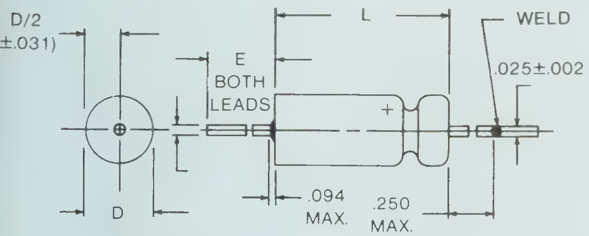
4 0 E W 336 A 050 K 1 A

- 4 — TANTALUM CAPACITOR
- 0 — AXIAL LEAD
- E — SERIES
- W — WET ELECTROLYTE
- 336 — CAPACITANCE IN PICOFARADS
  First two digits are significant figures
  Third digit number of zeros to follow.
  335 = 3.3 uF
  336 = 33 uF
- A — CASE SIZE
- 050 — VOLTAGE RATING @ 85 C
- K — CAPACITANCE TOLERANCE
  J = ±5% K = ±10% M = ±20%
- 1 — 0 = UNSLEEVED, 1 = SLEEVED
- A — INDUSTRIAL

SERIES 40EW

Industrial Type Tantalum Capacitors

OUTLINE DRAWING AND DIMENSIONS



Dimensions — Inches (mm)

Case Size	L*	D		E
	±.031 (0.79)	±.016 (0.41) Uninsulated	Max Insulated	±.250 (6.35)
A	.453 (11.51)	.188 (4.78)	.219 (5.56)	1.500 (38.10)
B	.641 (16.28)	.281 (7.14)	.312 (7.92)	2.250 (57.15)
C	.766 (19.46)	.375 (9.53)	.406 (10.31)	2.250 (57.15)
D	1.062 (26.98)	.375 (9.53)	.406 (10.31)	2.250 (57.15)

*For insulated style, shrinkable sleeving laps over the ends of the case

Case Size	Capacitance uF	WVDC/ Surge 85°C	WVDC/ Surge 125°C	Max DF 25°C %	Max Impedance −55°C (Ohms)	Max D-c Leakage Current (ua)		Max Capacitance Change (%)			Max RMS Ripple Current (Milliamps)		Part Number ±10%
						25C	85C/125C	−55C	+85C	+125C	+85C	+125C	
A	220	6/7	4/4.7	32.5	30	2	9	−65	+13	+16	50	40	40EW227A006K1A
B	820	6/7	4/4.7	70.0	16	3	14	−80	+16	+20	250	200	40EW827B006K1A
C	1500	6/7	4/4.7	91.0	12	5	20	−85	+20	+25	500	400	40EW158C006K1A
D	2200	6/7	4/4.7	82.5	10	6	24	−80	+20	+25	750	550	40EW228D006K1A
A	180	8/9.2	5/5.8	22.5	32	2	9	−60	+13	+16	50	40	40EW187A008K1A
B	680	8/9.2	5/5.8	58.5	16	3	14	−80	+16	+20	250	200	40EW87B008K1A
C	1500	8/9.2	5/5.8	72.5	13	5	20	80	+20	+25	500	400	40EW158C008K1A
D	1800	8/9.2	5/5.8	72.5	11	7	25	-80	+20	+25	750	550	40EW188D008K1A
A	150	10/11.6	7/8.2	23.0	33	2	9	−50	+13	+16	50	40	40EW157A010K1A
B	560	10/11.6	7/8.2	59.0	17	3	16	−70	+16	+20	250	200	40EW567B010K1A
C	1200	10/11.6	7/8.2	61.0	13	5	20	−75	+20	+25	500	400	40EW128C010K1A
D	1500	10/11.6	7/8.2	61.0	12	7	25	−75	+20	+25	750	550	40EW158D010K1A
A	100	15/17.5	10/11.6	21.5	40	2	9	−40	+13	+16	50	40	40EW107A015K1A
B	390	15/17.5	10/11.6	40.5	18	3	16	−60	+16	+20	250	200	40EW397B015K1A
C	820	15/17.5	10/11.6	57.0	14	6	24	70	+20	+25	500	400	40EW827C015K1A
D	1000	15/17.5	10/11.6	50.0	12	8	32	−70	+20	+25	750	550	40EW108D015K1A
A	68	25/29	15/17.4	15.5	50	2	9	−35	+12	+15	50	40	40EW686A025K1A
B	270	25/29	15/17.4	25.0	19	3	16	−45	+13	+16	250	200	40EW277B025K1A
C	560	25/29	15/17.4	39.0	14	7	28	−60	+20	+25	500	400	40EW567C025K1A
D	680	25/29	15/17.4	40.0	13	8	29	−60	+20	+25	750	550	40EW687D025K1A
A	56	30/35	20/23.2	17.0	55	2	9	−32	+12	+15	50	40	40EW566A030K1A
B	220	30/35	20/23.2	23.0	20	3	16	−40	+13	+16	250	200	40EW227B030K1A
C	470	30/35	20/23.2	33.0	15	7	28	−55	+20	+25	500	400	40EW477C030K1A
D	500	30/35	20/23.2	33.0	14	8	32	−60	+20	+25	750	550	40EW567D030K1A
A	33	50/58	30/35	10.0	80	2	9	−24	+10	+12	50	40	40EW336A050K1A
B	120	50/58	30/35	13.9	26	3	16	−35	+12	+15	250	200	40EW127B050K1A
C	270	50/58	30/35	25.0	16	8	32	−40	+20	+25	500	400	40EW227C050K1A
D	330	50/58	30/35	27.5	15	9	36	−45	+20	+25	750	550	40EW337D050K1A
A	27	60/69	40/46	8.2	90	3	12	−20	+10	+12	50	40	40EW276A060K1A
B	100	60/69	40/46	11.5	28	4	20	−30	+12	+15	250	200	40EW107B060K1A
C	220	60/69	40/46	20.0	17	8	32	−35	+16	+20	500	400	40EW227C060K1A
D	270	60/69	40/46	23.0	16	9	36	−45	+16	+20	750	550	40EW277D060K1A
A	22	75/87	50/58	7.5	100	3	12	−16	+10	+12	50	40	40EW226A075K1A
B	82	75/87	50/58	11.5	33	4	24	−25	+12	+15	250	200	40EW826B075K1A
C	180	75/87	50/58	16.5	17	9	36	−30	+16	+20	500	400	40EW187C075K1A
D	220	75/87	50/58	18.5	16	10	40	−40	+16	+20	750	550	40EW227D075K1A
A	10	100/116	70/82	9.2	200	3	12	−17	+10	+12	50	40	40EW106A100K1A
B	39	100/116	70/82	10.9	80	5	24	−20	+12	+15	250	200	40EW396B100K1A
C	68	100/116	70/82	12.0	40	10	40	−30	+14	+16	500	400	40EW686C100K1A
D	120	100/116	70/82	25.9	30	12	48	−35	+15	+17	750	550	40EW127D100K1A
A	6.8	125/144	85/99	4.1	300	3	12	−14	+10	+12	50	40	40EW685A125K1A
B	27	125/144	85/99	7.5	90	5	24	-18	+12	+15	250	200	40EW276B125K1A
C	47	125/144	85/99	8.3	50	10	40	−26	+14	+16	500	400	40EW476C125K1A
D	82	125/144	85/99	17.5	32	12	48	−30	+15	+17	750	550	40EW826D125K1A

Approximate weight A 1.5 Gram C 6.5 Gram
B 3.4 Gram D 10.3 Gram

3

Tantalum Capacitors

SERIES 40EW
Industrial Type Tantalum Capacitors

TYPICAL CURVES
Capacitance Change With Temperature (120 Hz)

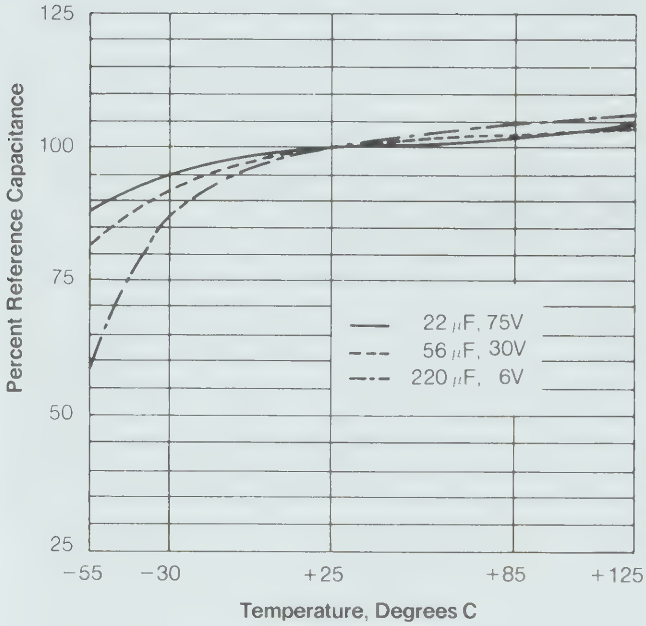


Fig. 1. Case Size A

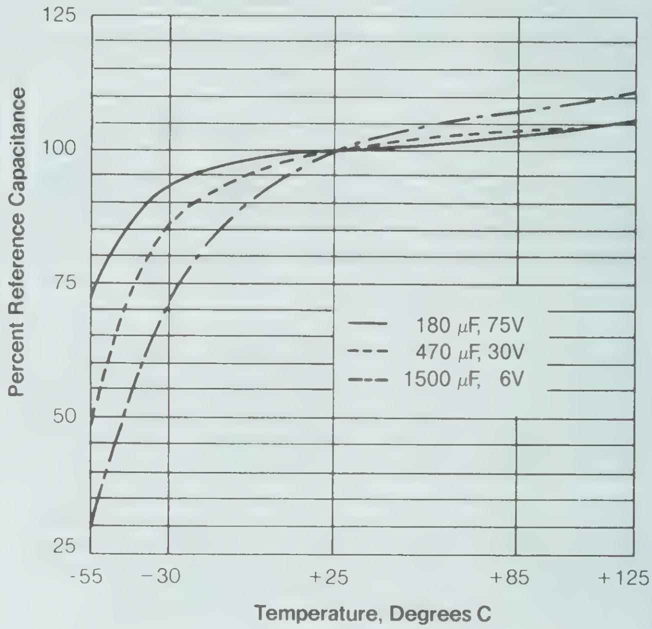


Fig. 3. Case Size C

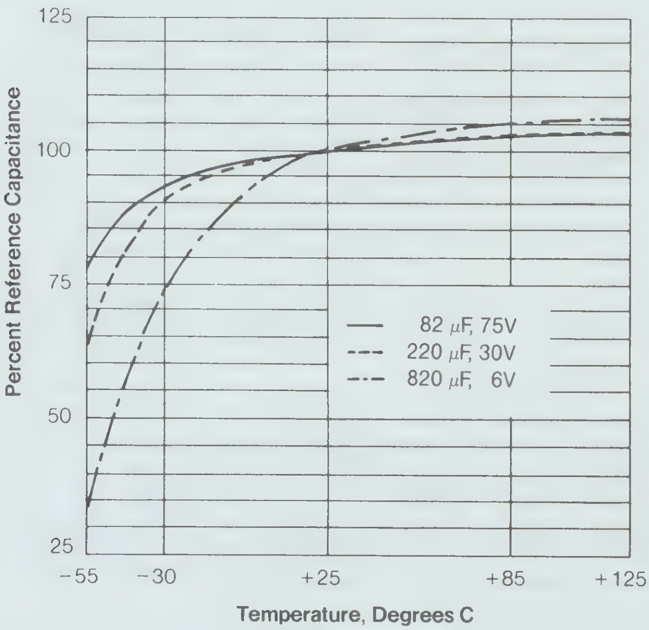


Fig. 2. Case Size B

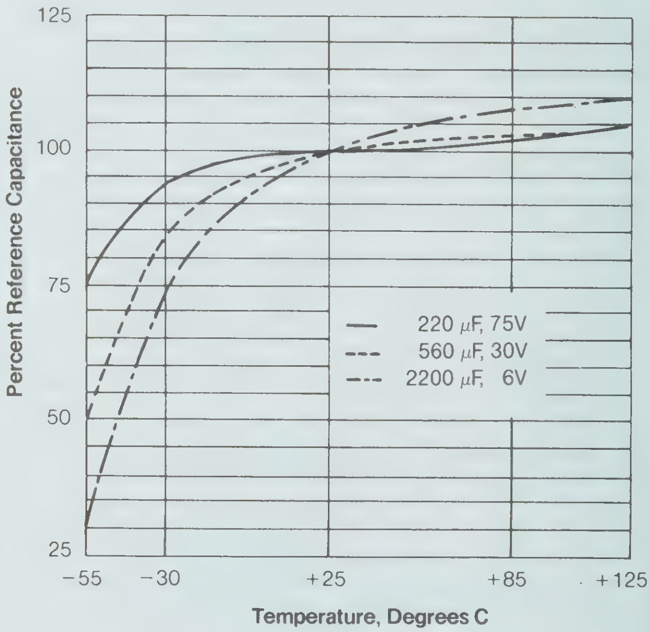


Fig. 4. Case Size D

3

Tantalum Capacitors

TYPICAL CURVES (Cont'd)
Equivalent Series Resistance (ESR) With Temperature (120 Hz)

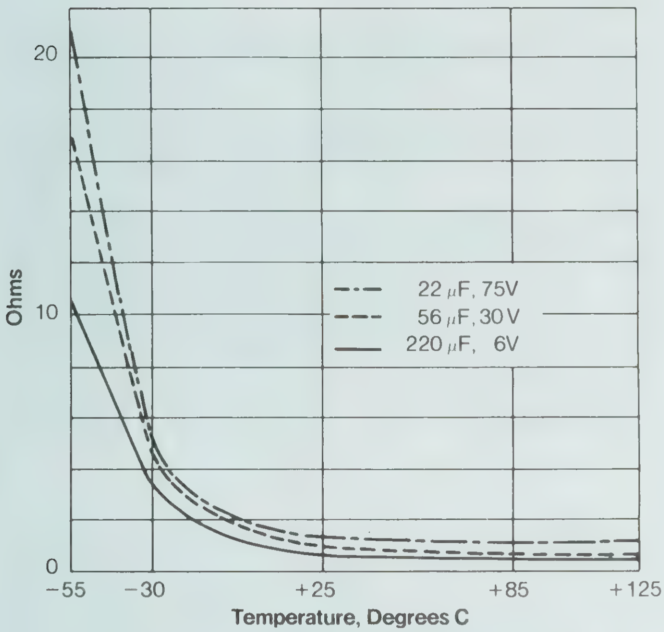


Fig. 5. Case Size A

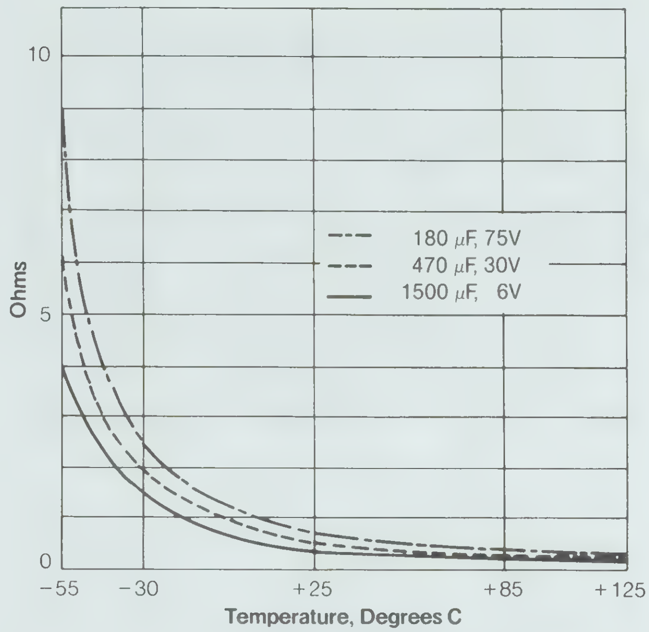


Fig. 7. Case Size C

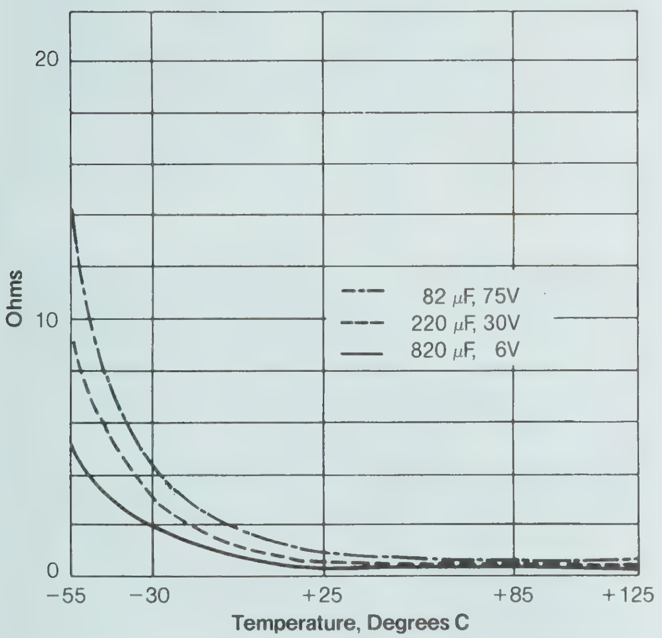


Fig. 6. Case Size B

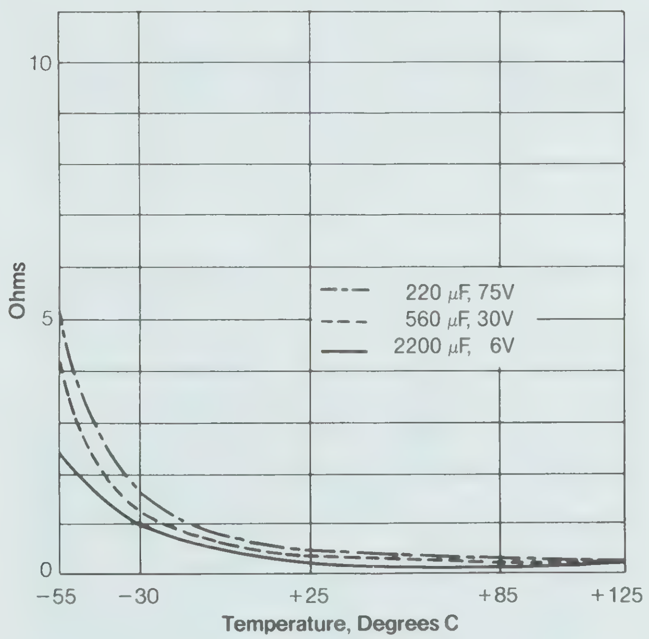


Fig. 8. Case Size D

TYPICAL CURVES (Cont'd)
Impedance With Frequency (Cont'd)

Case Size C

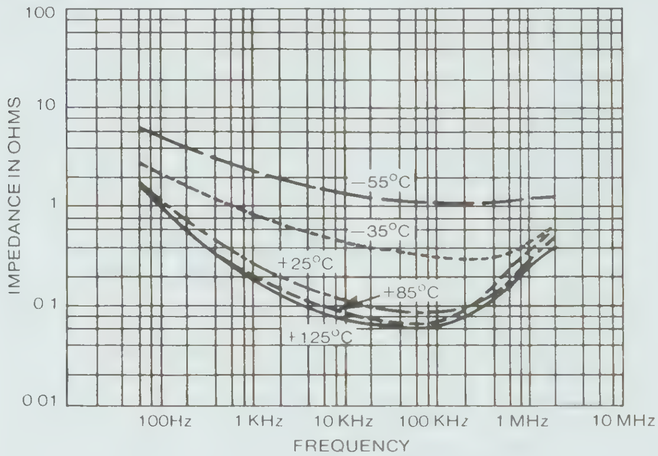


Fig. 15. 1500μf, 6 Volts.

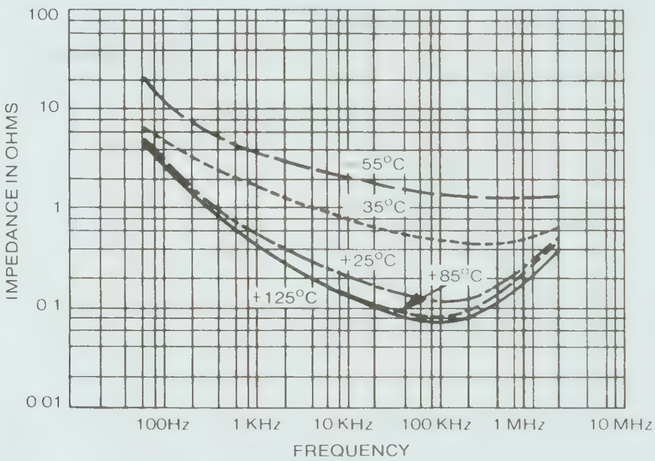


Fig. 16. 470μf, 30 Volts.

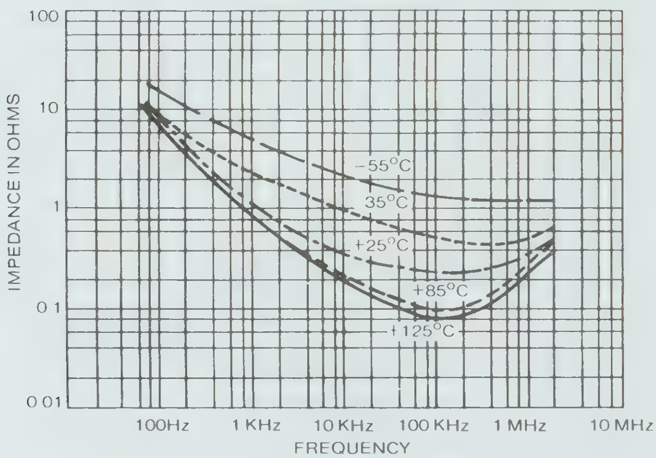


Fig. 17. 180μf, 75 Volts.

Case Size D

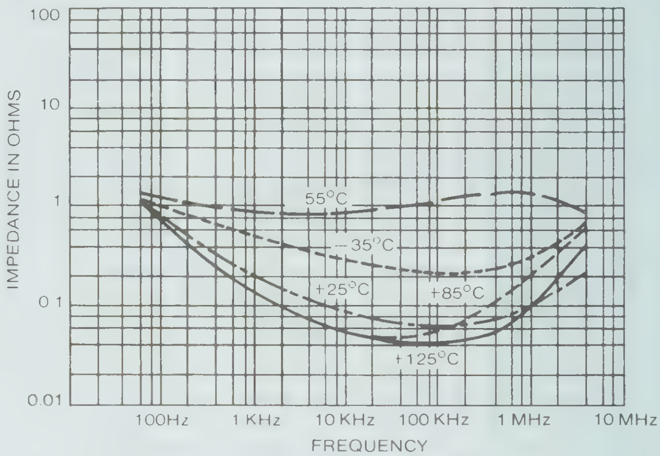


Fig. 18. 2200μf, 6 Volts.

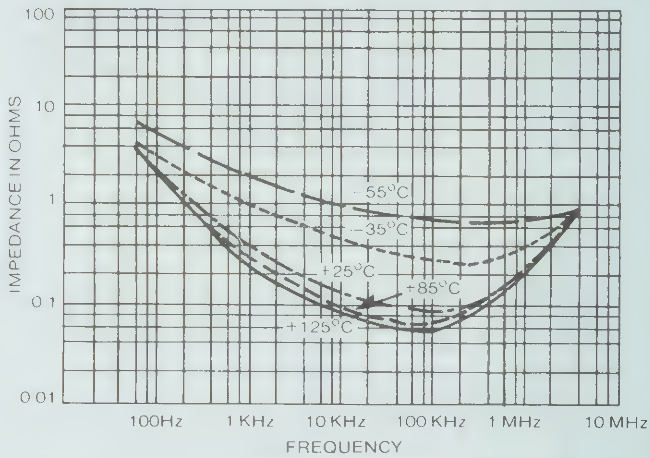


Fig. 19. 560μf, 30 Volts.

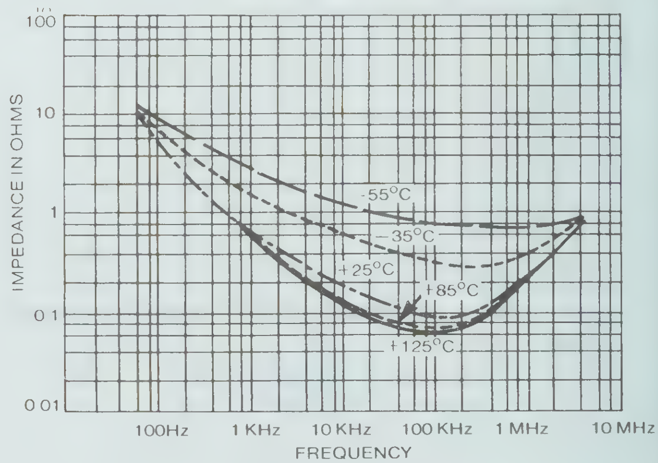


Fig. 20. 220μf, 75 Volts.

TYPICAL CURVES (Cont'd)
Impedance With Frequency

Case Size A

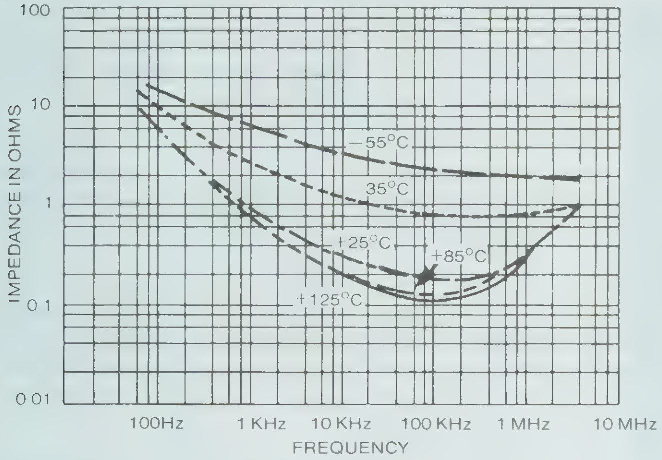


Fig. 9. 220μf, 6 Volts.

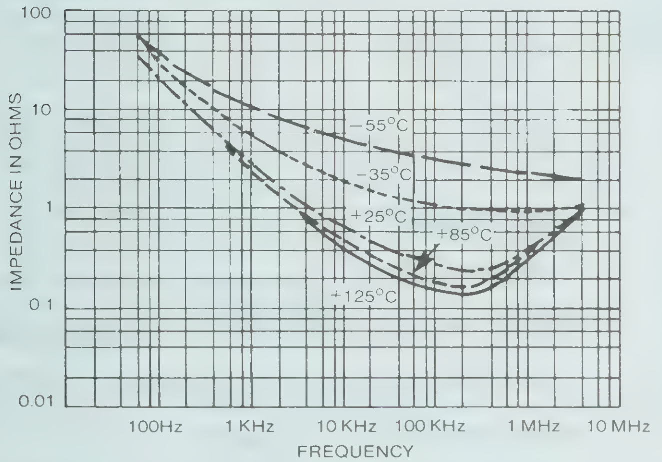


Fig. 10. 56μf, 30 Volts.

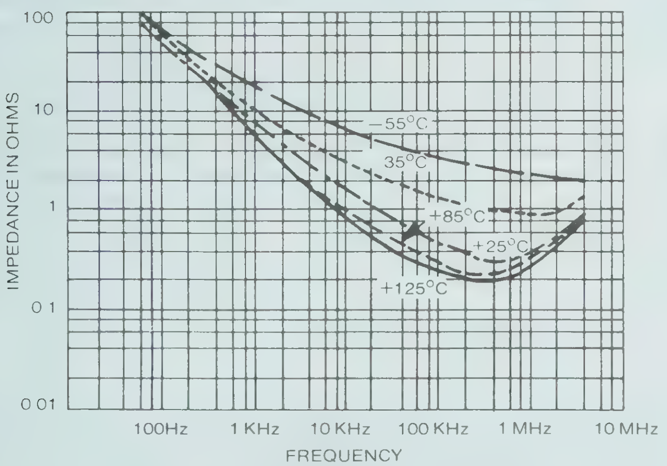


Fig. 11. 22μf, 75 Volts.

Case Size B

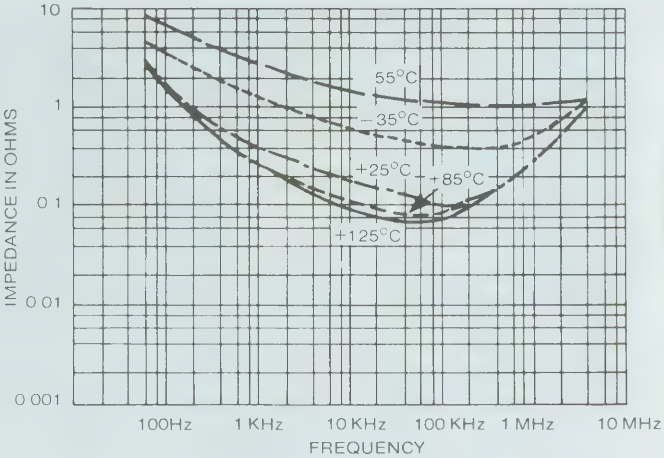


Fig. 12. 820μf, 6 Volts.

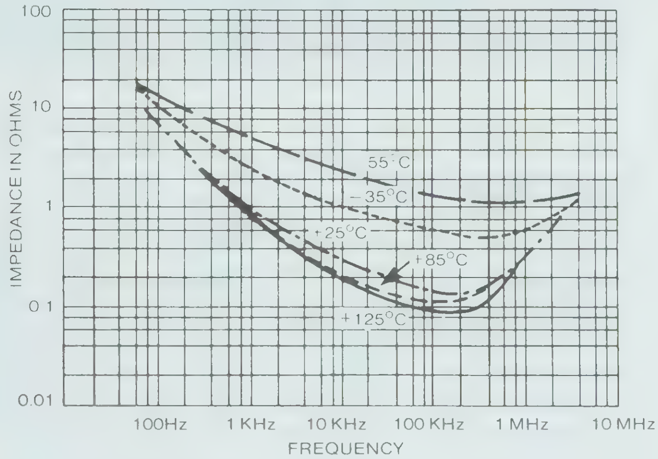


Fig. 13. 220μf, 30 Volts.

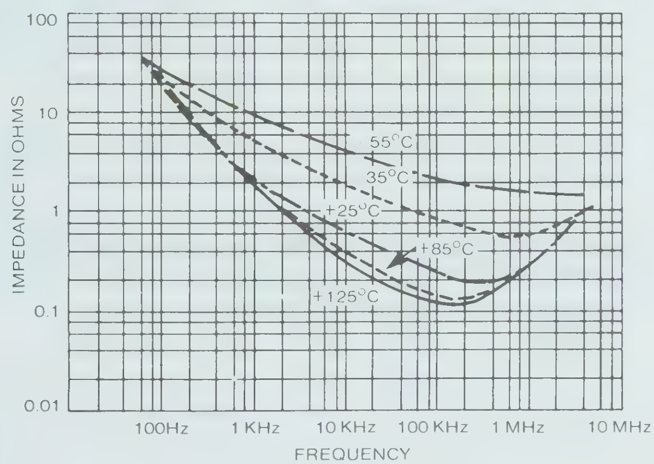
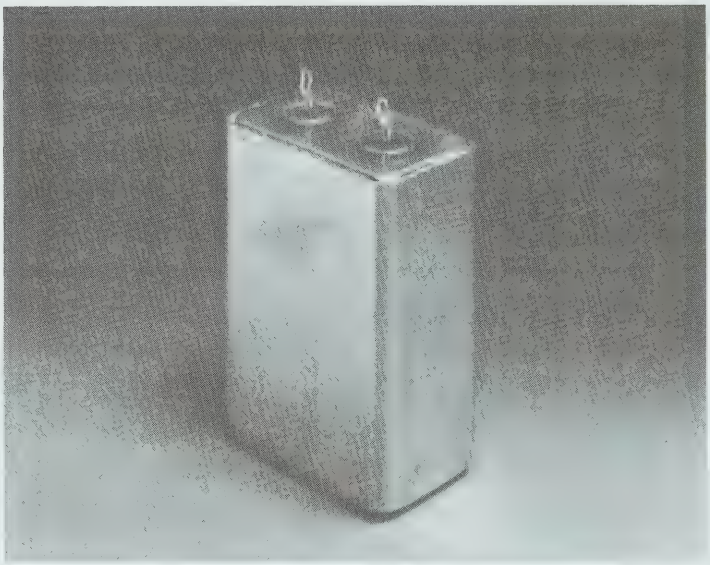


Fig. 14. 82μf, 75 Volts.

SERIES 43JW

Module Tantalum Capacitor



3

Tantalum Capacitors

DESCRIPTION

Philips Components 43JW Wet Tantalum Capacitors offer ultra-high capacitance and extremely small physical dimensions uniquely combined in an exclusive true glass-to-metal hermetic seal. This tested and proven design is manufactured in a rectangular case for easy mounting in any application.

Modern production facilities and highly trained, skilled personnel make it possible for Philips Components to produce tantalum capacitors having guaranteed low impedance, long life and extremely low loss characteristics.

The type 43JW series is designed to operate over the full military temperature range (−55°C to +125°C). Specifications and test conditions are presented on the following pages. Thixotropic gelled electrolyte assures electrical stability throughout extreme temperature ranges.

FEATURES

- HERMETIC SEAL
- HIGH CAPACITANCE IN ONE CONVENIENT CASE
- THIXOTROPIC GELLED ELECTROLYTE
- HIGHER RATINGS AVAILABLE
- AVAILABLE WITH ALL TANTALUM 40AW STYLE CELLS

WARNING
NON-SOLID ELECTROLYTIC CAPACITORS MAY CONTAIN CHEMICALS WHICH CAN BE REGARDED AS HAZARDOUS IF HANDLED INCORRECTLY. CAUTION IS NECESSARY IF THE OUTER CASE IS FRACTURED.

TEST SPECIFICATIONS

DESIGN AND CONSTRUCTION
43JW series is constructed from modular assemblies of Philips Components 40LW type straight wall 125°C wet electrolyte tantalum capacitors. Module assembly epoxy-encapsulated in tinned-metal case and sealed with glass-to-glass seals.

OPERATING TEMPERATURE RANGE
Designed to operate over a temperature range of −55°C to +85°C without derating. May be operated at 125°C with derating.

CAPACITANCE
Series capacitance measurements made by polarized bridge method at or referred to 120 Hz with 1.0VAC rms max and 2.2 VDC max @ +25°C. Capacitance shall be within the specified tolerance limits of nominal rating.

CAPACITANCE CHANGE WITH TEMPERATURE
Change in capacitance between initial measurements at +25°C ±5°C and measurements at temperatures listed below shall not exceed the applicable values specified at:

−55°C	−35 percent
+125°C	+25 percent

EQUIVALENT SERIES RESISTANCE (ESR)
Bridge measurements at or referred to 120 Hz with 1.0VAC rms max and 2.2 VDC max at a temperature of 25°C ±5°C. Measured equivalent series resistance shall not exceed the values shown for each rating.

LEAKAGE CURRENT
Measurements at rated working voltage at 25°C ±5°C with steady source of power applied (regulated power supply) with a 1000Ω resistance in series with capacitor under test. Rated working voltage applied for 5 mintues before making measurements. Maximum leakage current shall not exceed the listed maximum value.

LOW TEMPERATURE IMPEDANCE
Impedance value measured @ 120 Hz @ −55°C shall not exceed listed value.

DC WORKING VOLTAGE
WVDC is maximum operating voltage for continuous duty at rated temperature.

SURGE VOLTAGE
Surge dc rating is the maximum voltage under any condition. Includes transients and peak ripple at highest line voltage. Surge voltage is 115% of rated WVDC.

Surge test voltage applied through a 1000 ohm ±10% series resistor at rate of ½ minute on, 5½ minutes off, for 1000 successive test cycles @ 85°C.

Following surge test, capacitance @ 25°C not to change more than ±10%, dissipation factor not to exceed value shown and leakage current not to exceed stated requirements.

LIFE TEST
Tested for 2000 hours at rated dc working voltage @ 85°C. Leakage current not to exceed original requirements, equivalent series resistance not to exceed 130% of the initial requirement, and capacitance not to change more than ±25%.

HIGH FREQUENCY VIBRATION
Vibration from 10 to 2000 Hz @ 20g. Electrical measurements to show no intermittent open or short circuit during test.

After test, capacitance, ESR and leakage current shall meet the original requirements.

PULL TEST
Terminals shall withstand a tensile stress of 5 lbs. for 30 seconds applied axially.

MOISTURE RESISTANCE
Moisture resistance cycling test specified in MIL Standard 202, method 106. After test, capacitance, equivalent series resistance, and leakage current shall meet the original requirements.

SHELF TEST
A 2000-hour test @ 85°C with no voltage applied. Capacitance not to change more than 10% from the initial value, leakage current not to exceed requirements specified, and ESR not to exceed values stated.

THERMAL SHOCK AND IMMERSION
Tests specified in MIL Standard 202, method 107 and 104 to be complied with. After test, capacitance, ESR and leakage current shall meet the original requirements.

ALTITUDE
Stabilized at a reduced atmospheric pressure up to 100 miles for 5 minutes. Capacitors not to flash over with rated dc voltage applied 1 minute. End-seals not to be damaged. Electrical measurements shall show no intermittent contacts and capacitance, ESR and leakage current shall meet original limits.

POLARITY
Polarity will be indicated by a Red Glass Seal on the positive (+) terminal and a black glass seal on the negative (−) terminal.

Weight
Approximate

A	45 Grams
B	55 Grams
C	60 Grams
D	75 Grams
E	95 Grams

SERIES 43JW

Industrial Type Tantalum Capacitors

APPLICATION NOTES

DC Working Voltages

85°C WVDC	85°C Surge	125°C WVDC	125°C Surge
6	7	4	4.7
8	9.2	5	5.8
10	11.6	7	8.2
15	17.2	10	11.6
25	28.8	15	17.3
30	34.5	20	23.0
45	51.7	30	35.0
50	57.5	33	38.0
60	69.0	40	46.0
75	86.2	50	57.5
100	115	70	80.5
110	126.5	73	84.3
125	143.8	83	95.5
150	172	100	115.0

Philips Components Type 43JW Tantalum Capacitors will withstand the ripple current heating effects as shown in the typical operating data. In operation, the peak voltage across the capacitor (DC working voltage plus peak ripple voltage) must not exceed the rated working voltage of the capacitor. The DC component of the applied voltage should always be large with respect to the AC component to prevent polarity reversal.

Philips Components Type 43JW Tantalum Capacitors will withstand the ripple current heating effects equivalent to the values specified for each case size:

Case Size	Ripple Current (Amperes) at 120 Hz
A	0.8
B	1.0
C	1.2
D	1.8
E	2.0
F	1.5
G	2.0
H	2.5
J	3.0
K	3.5
L	4.0
M	4.5

PART NUMBER SYSTEM

EXAMPLE 4 3 J W 338 A 006 K 0 A J

- J — TERMINAL CONFIGURATION
  - J = Neither terminal connected to case internally.
  - K = Positive terminal connected to case internally.
  - L = Negative terminal connected to case internally.
- A — INDUSTRIAL
- 0 — 0 = UNSLEEVED
- K — CAPACITANCE TOLERANCE
  - J = ±5% K = ±10% M =±20%
- 006 — VOLTAGE RATING AT 85 C
- A — CASE SIZE
- 338 — CAPACITANCE IN PICOFARADS
  - First two digits are significant figures.
  - Third digit number of zeros to follow:
  - 338 = 3300 uF
  - 149 = 14000 uF
- W — WET ELECTROLYTE
- J — SERIES
- 3 — MODULE
- 4 — TANTALUM CAPACITOR

Case Size	Capacitance uF	WVDC @ 85°C	Max. D.C. Leakage Current (uA) 25°C	85°C	125°C	Max. ESR Ω	Max. Z Ω -55°C	Part Number ±10%
A	3300	6	4.0	24	36	.32	6.10	43JW338A006K0A
B	4400	6	5.5	33	49	.24	5.00	43JW448B006K0A
C	5500	6	6.5	39	59	.19	4.25	43JW558C006K0A
D	6600	6	8.0	48	72	.16	3.90	43JW668D006K0A
F	7200	6	10.8	65	108	.16	3.30	43JW728F006K0A
G	9600	6	14.4	86	144	.13	2.50	43JW968G006K0A
E	9800	6	12.0	72	108	.11	2.25	43JW988E006K0A
H	12000	6	18.0	108	180	.10	2.00	43JW129H006K0A
J	14000	6	21.0	126	210	.08	1.70	43JW149J006K0A
K	17000	6	25.5	153	255	.07	1.40	43JW179K006K0A
L	19000	6	28.5	171	285	.06	1.20	43JW199L006K0A
M	22000	6	33.0	198	330	.05	1.10	43JW229M006K0A
F	5100	8	10.2	61	102	.16	5.50	43JW518F008K0A
G	6800	8	13.6	82	136	.13	2.80	43JW688G008K0A
H	8500	8	17.0	102	170	.10	2.20	43JW858H008K0A
J	10000	8	20.0	120	200	.08	1.80	43JW109J008K0A
K	12000	8	24.0	144	240	.07	1.60	43JW129K008K0A
L	14000	8	28.0	168	280	.06	1.40	43JW149L008K0A
M	15000	8	30.0	180	300	.05	1.20	43JW159M008K0A
A	2300	10	4.5	27	40	.32	66.00	43JW238A010K0A
B	3000	10	6.0	36	54	.24	5.50	43JW308B010K0A
C	3800	10	7.5	45	67	.19	4.70	43JW388C010K0A
D	4500	10	9.0	54	81	.16	3.80	43JW458D010K0A
F	4500	10	11.3	68	113	.16	3.80	43JW458F010K0A
E	6000	10	12.0	72	108	.12	3.15	43JW608E010K0A
G	6000	10	15.0	90	150	.13	2.90	43JW608G010K0A
H	7500	10	18.8	113	188	.10	2.30	43JW758H010K0A
J	9000	10	22.5	135	225	.08	1.90	43JW908J010K0A
K	10000	10	25.0	150	250	.07	1.60	43JW109K010K0A
L	12000	10	30.0	180	300	.06	1.40	43JW129L010K0A
M	14000	10	35.0	210	350	.05	1.30	43JW149M010K0A
A	480	15	1.5	9	14	.41	6.80	43JW487A015K0A
A	960	15	3.0	18	27	.21	3.10	43JW967A015K0A
B	1200	15	3.5	21	32	.16	2.30	43JW128B015K0A
A	1400	15	4.0	24	36	.29	1.70	43JW148A015K0A
C	1400	15	4.0	24	36	.14	1.70	43JW148C015K0A
A	1600	15	5.0	30	45	.25	1.63	43JW168A015K0A
B	1900	15	5.5	33	49	.22	1.55	43JW198B015K0A
B	2100	15	6.0	36	54	.19	1.30	43JW218B015K0A
D	2100	15	6.0	36	54	.10	1.30	43JW218D015K0A
C	2400	15	7.0	42	63	.17	1.15	43JW248C015K0A
E	2400	15	7.0	42	63	.08	1.15	43JW248E015K0A
C	2700	15	8.0	48	72	.15	1.10	43JW278C015K0A
D	2900	15	9.0	54	81	.14	1.05	43JW298D015K0A
D	3200	15	10.0	60	90	.12	1.00	43JW328D015K0A
F	3200	15	12.0	72	120	.20	3.80	43JW328F015K0A
E	3900	15	12.0	72	108	.10	1.00	43JW398E015K0A
E	4300	15	13.0	78	117	.09	1.00	43JW438E015K0A
G	4300	15	16.2	97	162	.15	2.90	43JW438G015K0A
H	5400	15	20.3	122	203	.12	2.30	43JW548H015K0A
J	6500	15	24.4	147	244	.10	1.90	43JW658J015K0A
K	7600	15	28.5	171	285	.09	1.60	43JW768K015K0A
L	8600	15	32.3	194	323	.08	1.40	43JW868L015K0A
M	9700	15	36.4	219	364	.07	1.30	43JW978M015K0A

SERIES 43JW

Industrial Type Tantalum Capacitors

3

Tantalum Capacitors

Case Size	Capacitance uF	WVDC @85°C	Max. D.C. Leakage Current (uA) 25°C	85°C	125°C	Max. ESR Ω	Max. Z Ω -55°C	Part Number ±10%
F	2100	25	13.2	79	132	.20	4.00	43JW218F025K0A
G	2800	25	17.5	105	175	.16	3.00	43JW288G025K0A
H	3500	25	21.9	132	219	13	2.40	43JW358H025K0A
J	4200	25	26.3	158	263	.10	2.00	43JW428J025K0A
K	4900	25	30.7	184	307	09	1.70	43JW498K025K0A
L	5600	25	35.0	210	350	.08	1.50	43JW568L025K0A
M	6300	25	39.4	237	394	.07	1.30	43JW638M025K0A
A	270	30	1.5	9	14	.74	8.50	43JW277A030K0A
A	520	30	3.0	18	27	38	5.30	43JW527A030K0A
B	660	30	4.0	24	36	30	4.20	43JW667B030K0A
A	820	30	5.0	30	45	40	2.90	43JW827A030K0A
C	820	30	5.0	30	45	24	2.90	43JW827C030K0A
A	900	30	5.5	33	49	.37	2.75	43JW907A030K0A
B	1100	30	6.5	39	59	30	2.50	43JW118B030K0A
B	1200	30	7.0	42	63	.28	2.30	43JW128B030K0A
D	1200	30	7.0	42	63	17	2.30	43JW128D030K0A
E	1300	30	8.0	48	72	15	2.10	43JW138E030K0A
C	1400	30	8.0	48	72	24	2.00	43JW148C030K0A
C	1500	30	9.0	54	81	22	2.40	43JW158C050K0A
D	1600	30	10.0	60	90	21	2.30	43JW168D030K0A
D	1800	30	11.0	66	99	19	2.25	43JW188D030K0A
F	1800	30	13.5	81	135	25	4.20	43JW188F030K0A
E	2200	30	13.0	78	117	15	1.40	43JW228E030K0A
E	2400	30	14.0	84	126	14	1.20	43JW248E030K0A
G	2400	30	18.0	108	180	19	3.10	43JW248G030K0A
H	3000	30	22.5	135	225	15	2.50	43JW308H030K0A
J	3600	30	27.0	162	270	12	2.10	43JW368J030K0A
K	4200	30	31.5	189	315	11	1.80	43JW428K030K0A
L	4800	30	36.0	216	360	10	1.60	43JW488L030K0A
M	5400	30	40.5	243	405	08	1.40	43JW548M030K0A
A	430	45	4.0	24	36	62	7.20	43JW437A045K0A
B	550	45	5.0	30	45	48	5.60	43JW557B045K0A
A	570	45	5.0	50	45	47	4.80	43JW577A045K0A
B	600	45	5.5	30	49	45	4.60	43JW607B045K0A
C	660	45	6.0	36	54	40	4.00	43JW667C045K0A
B	750	45	7.0	42	63	35	3.70	43JW757B045K0A
B	800	45	7.5	45	67	33	3.10	43JW807B045K0A
C	940	45	7.5	45	67	28	2.90	43JW947C045K0A
C	1000	45	9.0	54	81	27	2.80	43JW108C045K0A
D	1000	45	9.0	54	81	27	2.80	43JW108D045K0A
E	1100	45	10.0	60	90	.24	2.70	43JW118E045K0A
D	1200	45	11.0	66	99	22	2.50	43JW128D045K0A
E	1500	45	13.0	78	117	.18	2.40	43JW158E045K0A
E	1600	45	14.5	87	130	.17	2.30	43JW168E045K0A
A	200	50	2.0	12	18	.99	8.10	43JW207A050K0A
A	400	50	4.0	24	36	50	7.20	43JW407A050K0A
A	430	50	4.5	27	41	47	6.40	43JW437A050K0A
A	480	50	5.0	30	45	.55	5.90	43JW487A050K0A
B	500	50	5.0	30	45	40	5.60	43JW507B050K0A
C	600	50	6.0	36	54	.33	4.10	43JW607C050K0A
B	640	50	6.5	39	59	.42	3.90	43JW647B050K0A
C	800	50	8.0	48	72	.33	3.10	43JW807C050K0A
D	800	50	8.0	48	72	25	3.10	43JW807D050K0A
E	960	50	9.5	57	85	.28	2.45	43JW967E050K0A
F	960	50	12.0	72	120	.30	4.50	43JW967F050K0A
E	1000	50	10.0	60	90	.20	2.80	43JW108E050K0A
E	1300	50	13.0	78	117	.21	2.70	43JW138E050K0A
G	1300	50	16.3	98	163	.26	3.40	43JW138G050K0A
H	1600	50	20.0	120	200	.18	2.70	43JW168H050K0A
J	1900	50	23.8	143	238	.15	2.30	43JW198J050K0A
K	2200	50	27.5	165	275	.13	1.90	43JW228K050K0A
L	2600	50	32.5	195	325	.12	1.70	43JW268L050K0A
M	2900	50	36.3	218	363	.10	1.50	43JW298M050K0A

SERIES 43JW

Industrial Type Tantalum Capacitors

Case Size	Capacitance uF	WVDC @85°C	Max. D.C. Leakage Current (uA) 25°C	85°C	125°C	Max. ESR Ω	Max. Z Ω -55°C	Part Number ±10%
A	400	60	5.0	30	45	.67	5.00	43JW407A060K0A
B	560	60	6.5	39	59	.48	3.10	43JW567B060K0A
C	700	60	8.5	51	76	.38	3.10	43JW707C060K0A
D	840	60	10.0	60	90	.32	2.70	43JW847D060K0A
F	840	60	12.6	76	126	.33	4.70	43JW847F060K0A
E	1100	60	13.0	78	117	.24	2.00	43JW118E060K0A
G	1100	60	16.5	99	165	.25	3.50	43JW118G060K0A
H	1400	60	21.0	126	210	.20	2.80	43JW148H060K0A
J	1700	60	25.5	153	255	.17	2.30	43JW178J060K0A
K	2000	60	30.0	180	300	.15	2.00	43JW208K060K0A
L	2200	60	33.0	198	330	.13	1.80	43JW228L060K0A
M	2500	60	37.5	225	375	.11	1.60	43JW258M060K0A
A	150	75	2.0	12	18	1.06	15.60	43JW157A075K0A
A	270	75	4.0	24	36	.59	8.50	43JW277A075K0A
A	330	75	5.0	30	45	.81	7.00	43JW337A075K0A
B	330	75	5.0	30	45	.49	7.00	43JW337B075K0A
A	400	75	6.0	36	54	.67	5.00	43JW407A075K0A
C	400	75	6.0	36	54	.40	5.00	43JW407C075K0A
B	440	75	6.5	39	59	.61	5.00	43JW447B075K0A
B	530	75	8.0	48	72	.50	4.80	43JW537B075K0A
C	550	75	8.5	51	76	.48	3.85	43JW557C075K0A
D	600	75	9.0	54	72	.27	3.65	43JW607D075K0A
C	660	75	10.0	60	90	.41	3.50	43JW667C075K0A
E	660	75	10.0	60	90	.24	3.50	43JW667E075K0A
F	660	75	12.4	75	124	.42	4.80	43JW667F075K0A
D	790	75	12.0	72	108	.34	3.10	43JW797D075K0A
E	880	75	13.0	78	117	.30	2.60	43JW887E075K0A
G	880	75	16.5	99	165	.31	3.60	43JW887G075K0A
E	1100	75	16.0	96	144	.24	1.40	43JW118E075K0A
H	1100	75	20.7	124	207	.25	2.90	43JW118H075K0A
J	1400	75	26.3	158	263	.21	2.40	43JW148J075K0A
K	1500	75	28.2	169	282	.18	2.10	43JW158K075K0A
L	1800	75	33.8	203	338	.15	1.80	43JW188L075K0A
M	2000	75	37.5	225	375	.14	1.60	43JW208M075K0A
A	85	100	2.0	12	18	1.88	31.50	43JW856A100K0A
A	170	100	3.5	21	32	.94	15.00	43JW177A100K0A
B	220	100	4.5	27	40	.73	11.60	43JW227B100K0A
A	260	100	5.0	30	45	.61	8.00	43JW267A100K0A
C	260	100	5.0	30	45	.61	8.00	43JW267C100K0A
B	350	100	7.0	42	63	.46	6.50	43JW357B100K0A
D	350	100	7.0	42	63	.46	6.50	43JW357D100K0A
C	440	100	9.0	54	72	.36	5.80	43JW447C100K0A
E	440	100	9.0	54	72	.36	5.80	43JW447E100K0A
F	510	100	12.8	77	128	.50	5.00	43JW517F100K0A
D	530	100	11.0	66	99	.30	5.70	43JW537D100K0A
G	680	100	17.0	102	170	.37	3.80	43JW687G100K0A
E	700	100	14.0	84	126	.23	4.10	43JW707E100K0A
H	850	100	21.3	128	213	.30	3.00	43JW857H100K0A
J	1000	100	25.0	150	250	.25	2.50	43JW108J100K0A
K	1200	100	30.0	180	300	.21	2.10	43JW128K100K0A
L	1400	100	35.0	210	350	.19	1.90	43JW148L100K0A
M	1500	100	37.5	225	375	.17	1.70	43JW158M100K0A

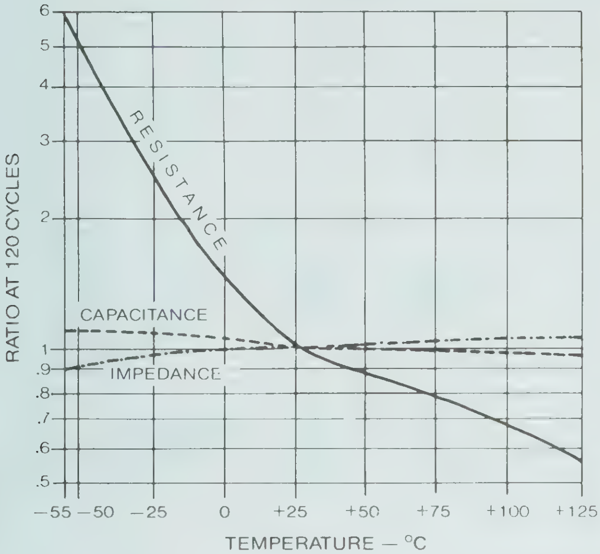
SERIES 43JW
Industrial Type Tantalum Capacitors

3

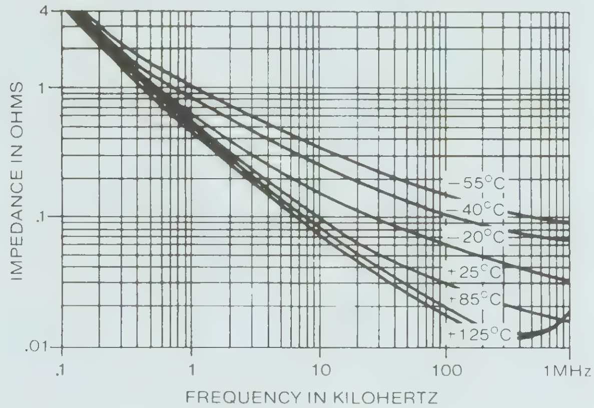
Tantalum Capacitors

Case Size	Capacitance uF	WVDC @85°C	Max. D.C. Leakage Current (uA) 25°C	85°C	125°C	Max. ESR Ω	Max. Z Ω -55°C	Part Number ±10%
A	140	110	3.0	18	27	1.14	22.00	43JW147A110K0A
B	180	110	4.0	24	36	.89	20.00	43JW187B110K0A
C	220	110	5.0	30	45	.73	10.00	43JW227C110K0A
A	240	110	5.5	33	49	.67	13.00	43JW247A110K0A
B	320	110	7.0	42	63	.50	8.20	43JW327B110K0A
E	360	110	8.0	48	72	.45	7.40	43JW367E110K0A
C	400	110	9.0	54	81	.40	7.00	43JW407C110K0A
D	480	110	10.5	63	94	.33	5.80	43JW487D110K0A
E	640	110	14.0	84	126	.25	4.90	43JW647E110K0A
A	170	125	4.0	24	36	.94	20.00	43JW177A125K0A
A	180	125	4.5	27	40	.89	19.00	43JW187A125K0A
B	220	125	5.5	33	49	.73	16.00	43JW227B125K0A
B	240	125	6.0	36	54	.67	14.00	43JW247B125K0A
C	280	125	7.0	42	63	.57	13.00	43JW287C125K0A
C	300	125	7.5	45	67	.53	12.00	43JW307C125K0A
D	340	125	8.5	51	76	.47	8.30	43JW347D125K0A
F	340	125	10.7	64	107	.67	5.50	43JW347F125K0A
E	350	125	8.5	51	76	.46	8.20	43JW357E125K0A
D	360	125	9.0	54	81	.45	8.30	43JW367D125K0A
G	450	125	14.1	85	141	.50	4.10	43JW457G125K0A
E	480	125	12.0	72	108	.33	7.30	43JW487E125K0A
H	560	125	17.5	105	175	.40	3.30	43JW567H125K0A
J	670	125	21.0	126	210	.33	2.80	43JW677J125K0A
K	790	125	24.7	149	247	.29	2.40	43JW797K125K0A
L	900	125	28.2	169	282	.25	2.10	43JW907L125K0A
M	1000	125	31.3	188	313	.22	1.80	43JW108M125K0A
A	35	150	1.0	6	9	4.55	40.00	43JW356A150K0A
A	60	150	2.0	12	18	2.66	33.00	43JW606A150K0A
A	70	150	2.0	12	18	2.28	28.80	43JW706A150K0A
B	90	150	2.5	15	22	1.76	22.40	43JW907B150K0A
C	100	150	3.0	18	27	1.60	16.40	43JW107C150K0A
B	120	150	3.5	21	32	1.33	15.20	43JW127B150K0A
A	130	150	4.0	24	36	1.22	13.65	43JW137A150K0A
D	140	150	4.0	24	36	1.14	12.40	43JW147D150K0A
B	170	150	5.0	30	54	.84	11.45	43JW177B150K0A
D	180	150	5.5	33	49	.89	11.20	43JW187D150K0A
E	180	150	5.5	33	49	.89	11.20	43JW187E150K0A
C	220	150	6.5	39	59	.73	16.00	43JW227C150K0A
E	240	150	7.0	42	63	.67	8.30	43JW247E150K0A
D	260	150	8.0	48	72	.62	8.20	43JW267D150K0A
E	350	150	10.0	60	90	.46	8.10	43JW357E150K0A

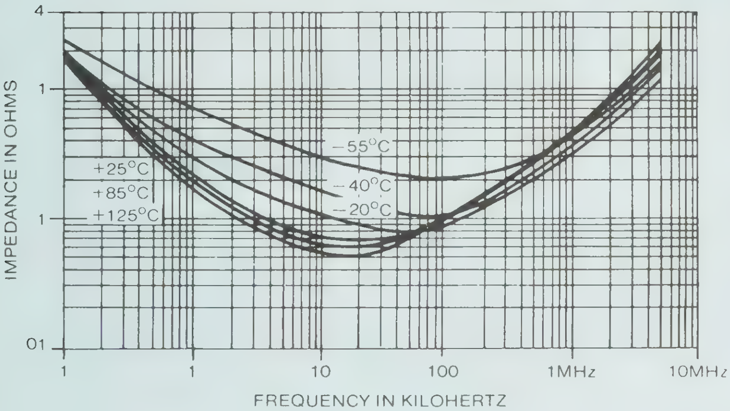
IMPEDANCE, CAPACITANCE, AND EQUIVALENT SERIES RESISTANCE WITH TEMPERATURE FOR TYPE 43JW507B050K0A



IMPEDANCE WITH FREQUENCY AT VARIOUS TEMPERATURES FOR TYPE 43JW267A100K0A



IMPEDANCE WITH FREQUENCY AT VARIOUS TEMPERATURES FOR TYPE 43JW108E050K0A



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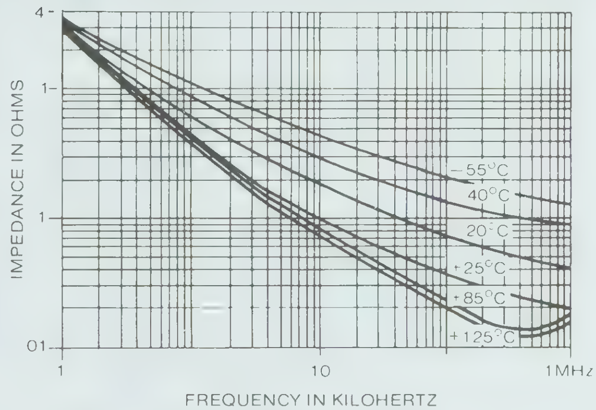
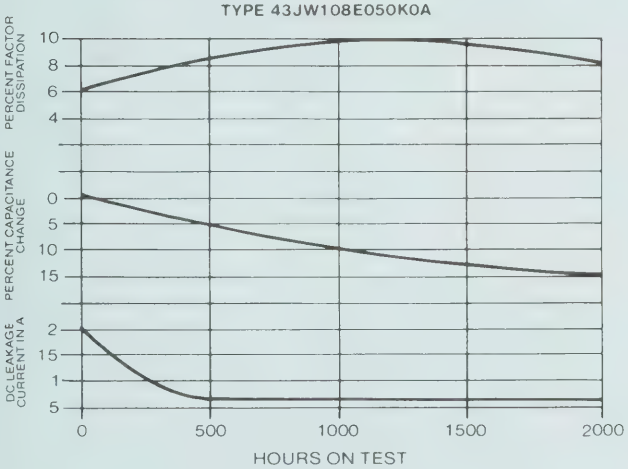


DISSIPATION FACTOR, CAPACITANCE CHANGE, AND DC LEAKAGE CURRENT AFTER LIFE TEST AT 125 C AND RATED VOLTAGE FOR TYPE 43JW108E050K0A



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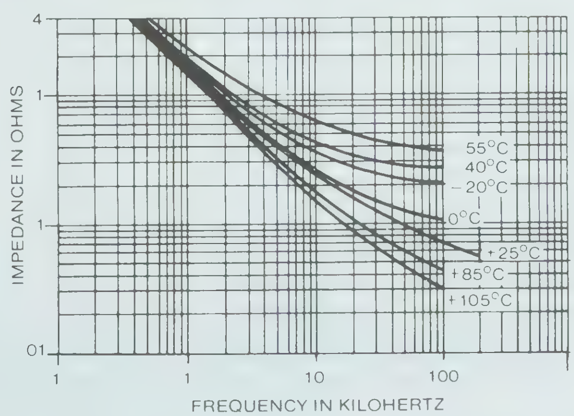
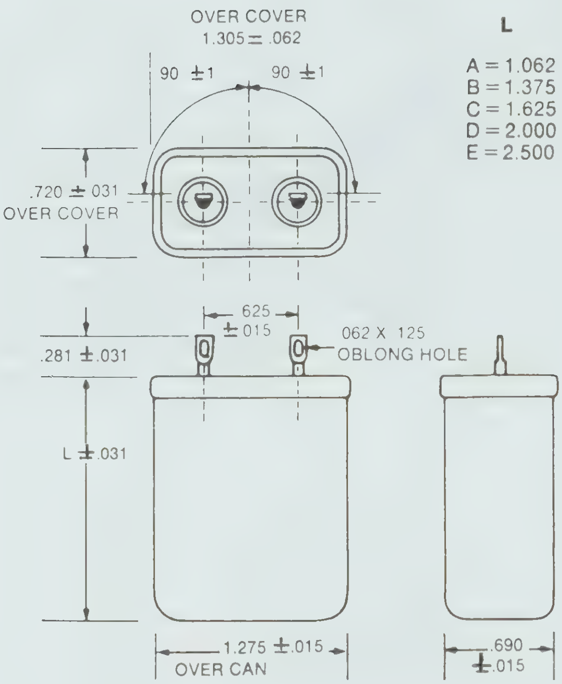
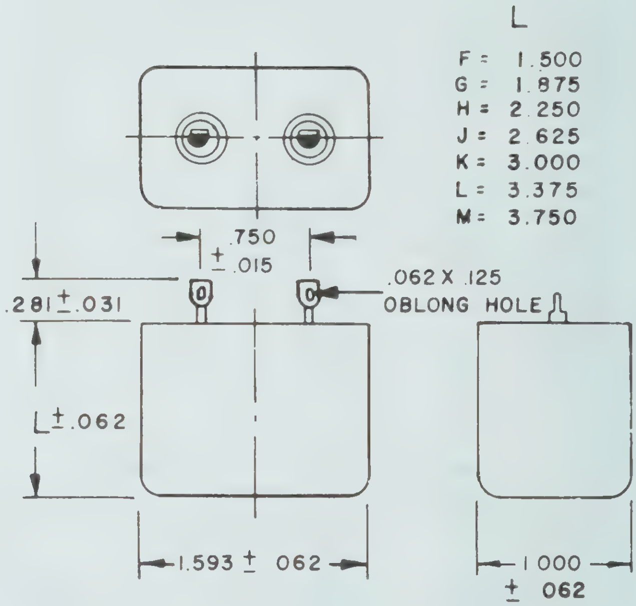


SERIES 43JW

Industrial Type Tantalum Capacitors

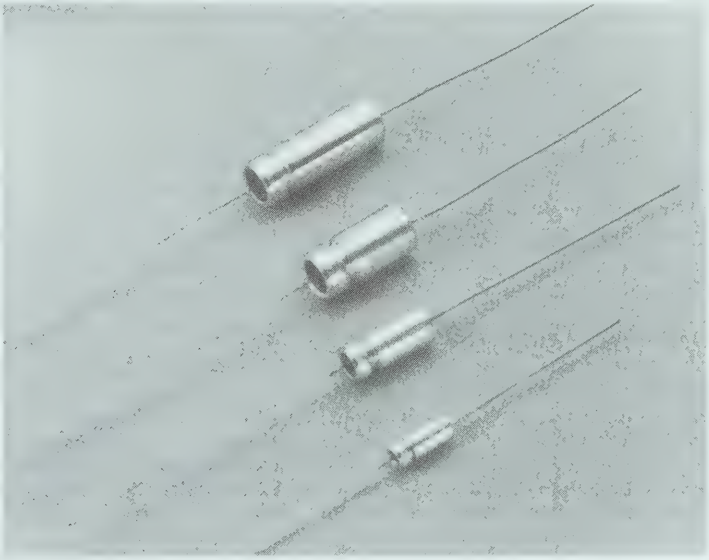
OUTLINE DRAWING AND DIMENSIONS





SERIES 40LW

Tubular Tantalum Capacitor



DESCRIPTION

Philips Components 40LW Type Tantalum Capacitors are uniquely designed. These capacitors offer extreme savings in both weight and space as compared with the conventional flange type construction. Savings up to 30% in weight and 40% in volume are available.

Philips Components research and development facilities, coupled with years of manufacturing experience, have resulted in these advantages, together with extremely low leakage current. These capacitors are normally supplied with an insulated case, without additional cost, for added protection in compact circuits.

FEATURES

- TUBULAR—POLAR
- THIXOTROPIC ELECTROLYTE
- SINTERED ANODE
- TANTALUM CAPACITOR
- 85°C—125°C WITH DERATING
- ELASTOMER SEAL

WARNING
NON-SOLID ELECTROLYTIC CAPACITORS MAY CONTAIN CHEMICALS WHICH CAN BE REGARDED AS HAZARDOUS IF HANDLED INCORRECTLY. CAUTION IS NECESSARY IF THE OUTER CASE IS FRACTURED.

SERIES 40LW

Industrial Type Tantalum Capacitors

Voltage Rating 85°C	Voltage Rating 125°C
6	4
8	5
10	7
15	10
25	15
30	20
50	30
60	40
75	50
100	70
125	85

OPERATING TEMPERATURE RANGE

Philips Components 40LW Type Tantalum Capacitors are designed to operate over a temperature range of −55°C to +85°C without derating.

DC WORKING VOLTAGE

The dc working voltage is the maximum operating voltage for continuous duty at the rated temperature.

SURGE VOLTAGE

The surge dc rating is the maximum voltage to which the capacitors should be subjected under any conditions. This includes transients and peak ripple at the highest line voltage. The surge voltage of all 40LW Type Tantalum Capacitors is 115% of rated dc working voltage.

The capacitors shall withstand the surge test voltage applied through a 1000 ohm +10% resistor in series with the capacitor and voltage source at the rate of ½ minute on, 5½ minutes off, for 1000 successive test cycles at 85°C.

Following the surge test the capacitance at 25°C shall not have changed by more than ±10%, the equivalent series resistance will not exceed the value shown in the tables for each capacitor, and the leakage current will not exceed the requirements of paragraph 7. Not more than 1 failure for any of the above reasons shall be allowed for any 12 samples tested.

CAPACITANCE

Capacitance measurements shall be made at or referred to 120 Hz and a temperature of +25°C.

The capacitance of all capacitors shall be within the specified tolerance limits of the nominal rating.

CAPACITANCE CHANGE WITH TEMPERATURE

Capacitance change with temperature shall not exceed the limits given in the tables for each capacitor.

DISSIPATION FACTOR

Measurements shall be made by the bridge method at or referred to a frequency of 120 Hz at a temperature of +25°C.

The Dissipation Factor shall not exceed the maximum value in percent listed in the tables for each capacitor.

LEAKAGE CURRENT

Measurements shall be made at rated working voltage with an application of a steady source of power, such as a regulated power supply with a 1000 ohm resistance to limit the charging current, connected in series with each capacitor under test. Rated working voltage shall be applied to capacitors for 5 mintues before making leakage current measurements.

The maximum leakage current for any capacitor shall not exceed the maximum value in microamperes listed in the tables.

LOW TEMPERATURE IMPEDANCE

The impedance of any capacitor, at −55°C and 120 Hz, shall not exceed the values given in the tables for each capacitor.

LIFE TEST

Capacitors are capable of withstanding a 2000 hour life test at a temperature of 85°C at rated dc working voltage.

After the life test, the leakage current shall not be in excess of the original requirement, the equivalent series resistance shall not be more than 130% of the initial requirement, and the capacitance value shall not have increased by more than 25% or decreased by more than 15% from the initial value.

Not more than 1 failure shall be permitted in 12 units tested.

LOW FREQUENCY VIBRATION

Capacitors shall withstand a simple harmonic motion having an amplitude of 0.03" (max. total excusrion 0.06") with the frequency being varied uniformly between the approximate limits of 10 to 55 Hz and ratings to be transversed in approximately 1 minute for a total of 1½ hours.

After vibration test, capacitors shall meet the original requirements for capacitance tolerance, equivalent series resistance, and leakage current.

HIGH FREQUENCY VIBRATION

Capacitors shall withstand vibration from 10 to 2000 Hz at 15g without internal damage. Electrical measurements made while under these conditions shall show no intermittent open or short circuit.

Capacitors shall be securely fastened by means of suitable component clips or brackets.

PULL TEST

Leads shall withstand a tensile stress of 3 lbs. for 30 seconds applied axially.

LEAD BEND TEST

Leads shall meet the bend test described in MIL-C-39006.

MOISTURE RESISTANCE

Capacitors shall withstand the moisture resistance cycling test specified in MIL Standard 202C, method 106A, without departure from the original limits of capacitance, equivalent series resistance, and leakage current.

SHELF TEST

Capacitors shall withstand a 2000 hour shelf test at 125°C with no voltage applied.

Following the shelf test, the capacitance shall not have changed by more than ±10% from the initial value and the leakage current and equivalent series resistance shall not exceed the values given in the tables for each capacitor.

THERMAL SHOCK AND IMMERSION

Capacitors shall withstand the thermal shock and immersion tests specified in MIL Standard 202C, method 107, test condition B, except that the low temperature shall be −55°C and method 104A, test condition B, respectively, without departure from the original limits for capacitance, equivalent series resistance, and leakage current.

REDUCED PRESSURE

Capacitors shall be stabilized at a reduced atmospheric pressure of 1.69×10^{-1} Torr. for a period of 5 minutes. Rated dc voltage shall be applied for 1 minute. Capacitors shall not flash over nor shall end seals be damaged by this test nor should the capacitors be electrically effected insofar as capacitance, equivalent series resistance, or leakage current is concerned.

MARKING

Capacitors will be marked with Philips Component part marking type LW rated capacitance and tolerance, rated DC voltage and date code where space permits.

APPLICATION NOTES

120 CYCLE RIPPLE VOLTAGE

Capacitors in case size A will withstand the ripple current heating effects equivalent to 40 ma RMS at 120 Hz. Capacitors in case size B will withstand the ripple current heating effects equivalent to 200 ma RMS at 120 Hz. Capacitors in case size C will withstand the ripple current heating effects equivalent to 400 ma RMS at 120 Hz. Capacitors in case D and E will withstand the ripple current heating effects equivalent to 550 ma RMS at 120 Hz in operation, the peak voltage across the capacitor (dc working voltage plus peak ripple voltage) must not exceed the rated working voltage of the capacitor. The dc component of the applied voltage should be sufficiently large to prevent polarity reversal because of the ac component.

STORAGE LIFE

A storage life of ten years or more, with no voltage at room temperature, may be expected.

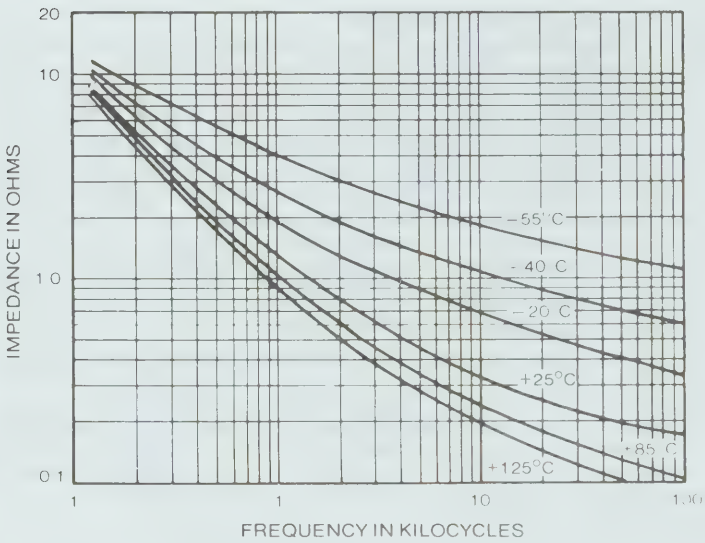
USE OF INDUSTRIAL SOLVENTS FOR CLEANING APPLICATIONS

The use of isopropyl alcohol is recommended for cleaning applications. Before using any other solvent, please consult the Philips Components Engineering Department.

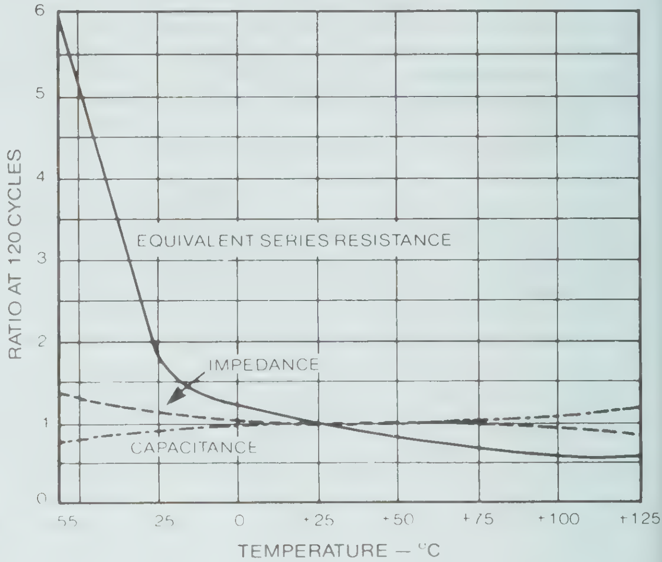
SERIES 40LW

Industrial Type Tantalum Capacitors

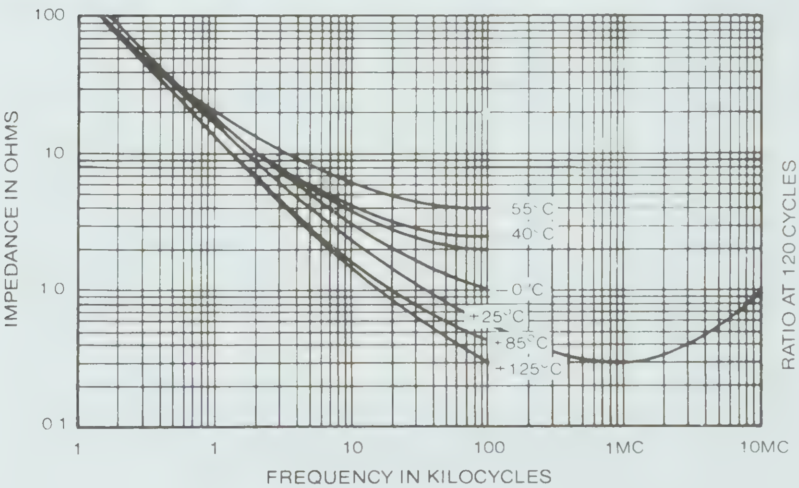
IMPEDANCE, CAPACITANCE AND EQUIVALENT SERIES RESISTANCE WITH TEMPERATURE FOR 40LW TYPE 140uF, 4 VOLT CAPACITORS



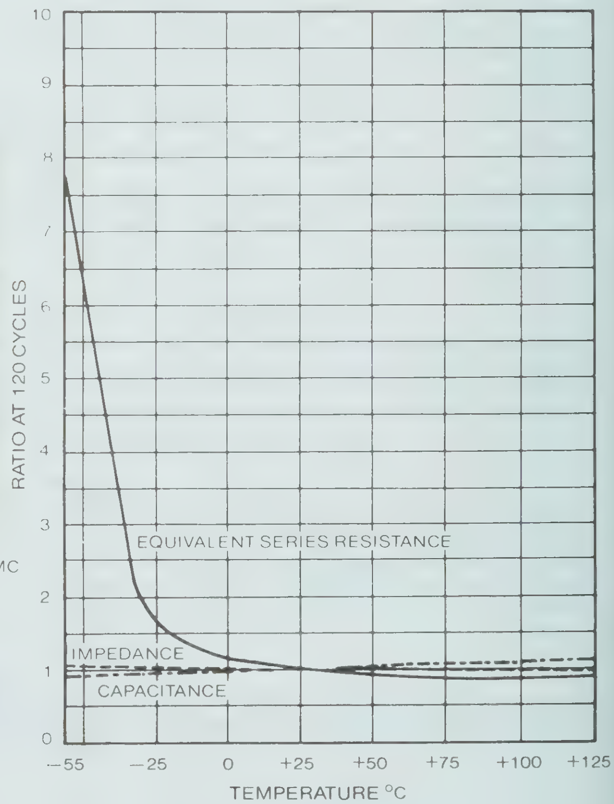
IMPEDANCE. WITH FREQUENCY AT VARIOUS TEMPERATURES FOR 40 LW TYPE 140uF, 4 VOLT CAPACITORS



IMPEDANCE, WITH FREQUENCY AT VARIOUS TEMPERATURES FOR 40 LW TYPE 11uF, 70 VOLT CAPACITORS



IMPEDANCE, CAPACITANCE AND EQUIVALENT SERIES RESISTANCE WITH TEMPERATURE FOR 40 W TYPE 11uF, 70 VOLT CAPACITORS



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SERIES 40LW

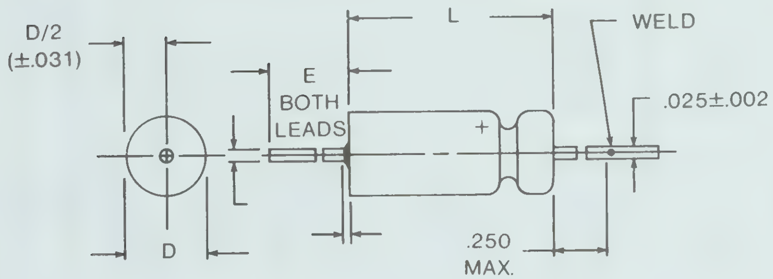
Industrial Type Tantalum Capacitors

PART NUMBER SYSTEM

EXAMPLE 4 0 L W 255 A 100 K 0 A

- 4 — TANTALUM CAPACITOR
- 0 — AXIAL LEAD
- L — SERIES
- W — WET ELECTROLYTE
- 255 — CAPACITANCE IN PICOFARADS
  First two digits are significant figures.
  Third digit number of zeros to follow:
  255 = 2.5 uF
  256 = 25 uF
- A — CASE SIZE
- 100 — VOLTAGE RATING @ 85°C
- K — CAPACITANCE TOLERANCE
  J = ±5% K = ±10% M = ±20%
- 0 — 0 = UNSLEEVED
  1 = SLEEVED
- A — INDUSTRIAL

OUTLINE DRAWING AND DIMENSIONS



Case Size	Dimensions—Inches (mm)				Approximate Weight (Grams)
	L*	D		E	
	±.031 (0.79)	±.016 (0.41) Uninsulated	Max Insulated	±.250 (6.35)	
A	.453 (11.51)	.188 (4.78)	.219 (5.56)	1.500 (38.10)	1.2
B	.641 (16.28)	.281 (7.14)	.312 (7.92)	2.250 (57.15)	3.1
C	.766 (19.46)	.375 (9.53)	.406 (10.31)	2.250 (57.15)	5.8
D	1.062 (26.98)	.375 (9.53)	.406 (10.31)	2.250 (57.15)	9.0

**For insulated style, the nonshrinkable sleeving extends .016 inch minimum, .062 inch maximum beyond each end of the case; shrinkable sleeving laps over the ends of the case.*

SERIES 40LW

Industrial Type Tantalum Capacitors

Case Size	uF	WVDC at 85°C	Max. D.F. at 25°C %	Max. Ω Impedance at −55°C	Max uA DC Leakage +25°C	+85°C	+125°C	Max. Capacitance Change in Percent −55°C	+125°C	Part Number ±10%
A	30	6	9.1	100	1.0	2.0	2.0	−50	+15	40LW306A006K1A
A	68	6	20.4	59	1.0	2.0	2.0	−50	+20	40LW686A006K1A
B	140	6	21.3	40	1.0	3.0	3.0	50	+20	40LW147B006K1A
B	270	6	81.8	25	1.0	6.5	6.5	−55	+25	40LW277B006K1A
C	330	6	49.6	20	1.0	7.9	7.9	−70	+20	40LW337C006K1A
C	560	6	128.0	25	2.0	13.0	13.0	-80	+25	40LW567C006K1A
D	1200	6	144.4	20	3.0	14.0	14.0	−80	+25	40LW128D006K1A
A	25	8	7.6	100	1.0	2.0	2.0	−50	+15	40LW256A008K1A
A	56	8	17.0	59	1.0	2.0	2.0	−40	+16	40LW566A008K1A
B	120	8	18.5	48	1.0	2.0	2.0	-50	+20	40LW127B008K1A
B	220	8	66.4	30	1.0	7.0	7.0	·44	+20	40LW227B008K1A
C	290	8	42.0	24	1.2	4.0	4.0	·70	+20	40LW297C008K1A
C	430	8	91.5	25	2.0	14.0	14.0	80	+25	40LW437C008K1A
D	850	8	65.8	22	4.0	16.0	16.0	−80	+25	40LW857D008K1A
A	20	10	6.1	120	1.0	2.0	2.0	·40	+15	40LW206A010K1A
A	47	10	18.1	90	1.0	2.0	2.0	−45	+20	40LW476A010K1A
B	100	10	15.2	60	1.0	4.0	4.0	45	+20	40LW107B010K1A
B	180	10	54.4	40	1.0	7.0	7.0	−45	+25	40LW187B010K1A
C	250	10	37.8	30	2.0	10.0	10.0	60	+20	40LW257C010K1A
C	390	10	87.6	25	2.0	16.0	16.0	−80	+25	40LW397C010K1A
D	750	10	56.5	23	4.0	16.0	16.0	−80	+25	40LW757D010K1A
A	15	15	5.7	145	1.0	2.0	2.0	−30	+15	40LW156A015K1A
A	33	15	12.5	90	1.0	2.0	2.0	-35	+20	40LW336A015K1A
B	70	15	13.1	63	1.0	4.0	4.0	-35	+20	40LW706B015K1A
B	120	15	36.8	50	1.0	7.0	7.0	−35	+25	40LW127B015K1A
C	170	15	25.4	35	2.0	8.0	8.0	−55	+20	40LW177C015K1A
C	270	15	60.9	30	2.0	16.0	16.0	70	+25	40LW277C015K1A
D	540	15	49.0	23	6.0	24.0	24.0	−80	+25	40LW547D015K1A
A	10	25	4.6	190	1.0	2.0	2.0	−20	+15	40LW106A025K1A
A	22	25	8.3	140	1.0	2.0	2.0	−25	+20	40LW226A025K1A
B	100	25	31.4	50	1.0	10.0	10.0	−35	+25	40LW107B025K1A
C	180	25	54.3	32	2.0	18.0	18.0	−60	+25	40LW187C025K1A
D	350	25	35.0	24	7.0	28.0	28.0	−70	+25	40LW357D025K1A

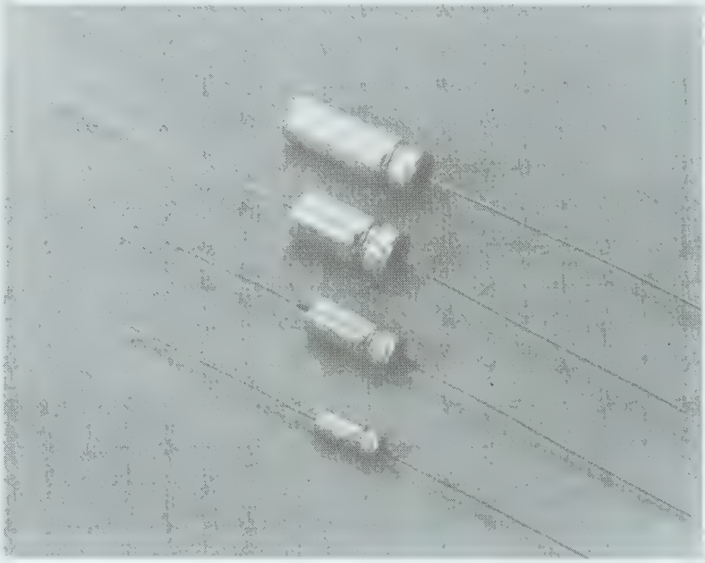
SERIES 40LW

Industrial Type Tantalum Capacitors

Case Size	uF	WVDC at 85°C	Max. D.F. at 25°C %	Max. Ω Impedance at −55°C	Max uA DC Leakage +25°C	Max uA DC Leakage +85°C	Max uA DC Leakage +125°C	Max. Capacitance Change in Percent −55°C	Max. Capacitance Change in Percent +125°C	Part Number ±10%
A	8	30	4.5	235	1	2	2	−20	+15	40LW805A030K1A
A	15	30	9.1	175	1	2	2	−25	+30	40LW156A030K1A
B	40	30	12.2	65	1	5	5	−30	+20	40LW406B030K1A
B	68	30	31.0	60	1	7.5	7.5	−30	+25	40LW686B030K1A
C	100	30	19.0	40	2	10	10	−45	+20	40LW107C030K1A
C	150	30	46.0	35	2	10	10	−60	+25	40LW157C030K1A
D	300	30	35.0	25	8	32	32	−60	+25	40LW307D030K1A
A	5	50	3.4	355	1	2	2	−20	+10	40LW505A050K1A
A	10	50	6.0	250	1	2	2	−30	+15	40LW106A050K1A
B	25	50	11.2	90	1	5	5	25	+20	40LW256B050K1A
B	47	50	21.4	70	1	8.5	8.5	−35	+25	40LW476B050K1A
C	60	50	13.6	45	2	10	10	−30	+20	40LW606C050K1A
C	82	50	24.9	45	2	12	12	−40	+25	40LW826C050K1A
D	160	50	25.7	27	8	32	32	−50	+20	40LW167D050K1A
A	4	60	3.0	405	1	2	2	−20	+10	40LW405A060K1A
A	8.2	60	5.0	275	1	2	2	−30	+15	40LW825A060K1A
B	20	60	7.6	105	1	5	5	−25	+15	40LW206B060K1A
B	39	60	20.7	90	1	9	9	−35	+20	40LW396B060K1A
C	50	60	15.3	50	2	10	10	25	+15	40LW506C060K1A
C	68	60	20.7	50	2	12	12	−40	+20	40LW686C060K1A
D	140	60	25.7	28	8	32	32	−40	+20	40LW147D060K1A
A	3.5	75	2.5	505	1	2	2	−20	+10	40LW355A075K1A
A	6.8	75	4.1	300	1	2	2	−25	+15	40LW685A075K1A
B	15	75	7.5	135	1	5	5	−20	+15	40LW156B075K1A
B	33	75	17.5	90	1	9	9	−30	+20	40LW336B075K1A
C	40	75	15.2	60	2	12	12	−20	+15	40LW406C075K1A
C	56	75	26.0	60	2	14	14	−35	+20	40LW566C075K1A
D	110	75	25.7	29	9	36	36	−35	+15	40LW117D075K1A
A	2.5	100	5.0	710	1	2	2	−15	+10	40LW255A100K1A
A	4.7	100	3.6	500	1	2	2	−20	+15	40LW475A100K1A
B	11	100	5.0	200	1	4	4	−16	+10	40LW116B100K1A
B	22	100	11.8	100	1	9	9	−20	+15	40LW226B100K1A
C	30	100	9.1	80	2	12	12	−15	+10	40LW306C100K1A
C	43	100	19.7	70	2	14	14	−25	+15	40LW436C100K1A
D	86	100	20.7	30	9	36	36	−25	+15	40LW866D100K1A
A	1.7	125	7.0	1090	1	2	2	−20	+10	40LW175A125K1A
A	3.6	125	4.1	600	1	2	2	−20	+15	40LW365A125K1A
B	9	125	10.2	220	1	5	5	−20	+15	40LW905B125K1A
B	14	125	12.7	160	1	7	7	−20	+15	40LW146B125K1A
C	18	125	15.0	93	2	13	13	−20	+20	40LW186C125K1A
C	25	125	19.0	85	2	16	16	−25	+20	40LW256C125K1A
D	56	125	18.5	30	10	40	40	−25	+15	40LW566D125K1A

SERIES 40SW

Tantalum-To-Glass Hermetic Seal Tantalum Capacitor



3

Tantalum Capacitors

DESCRIPTION

Philips Components 40SW type tantalum capacitors offer the "leak-proof" integrity of a tantalum-to-glass hermetic seal. This construction assures operational capability in space or deep oceanographic environments where dependability is required for tens of thousands of storage or operating hours. A product of Philips Components research and development, the 40SW type meets or exceeds the requirements of Mil-C-39006. Available in four case sizes with operation to 125°C.

FEATURES

- TANTALUM-TO-GLASS SEAL
- THIXOTROPIC ELECTROLYTE
- SINTERED ANODE
- TANTALUM CAPACITOR
- POLAR

WARNING

NON-SOLID ELECTROLYTIC CAPACITORS MAY CONTAIN CHEMICALS WHICH CAN BE REGARDED AS HAZARDOUS IF HANDLED INCORRECTLY. CAUTION IS NECESSARY IF THE OUTER CASE IS FRACTURED.

SERIES 40SW

Industrial Type Tantalum Capacitors

TANTALUM-TO-GLASS HERMETIC SEAL • FOR 125°C APPLICATIONS

CONSTRUCTION. The 40SW type uses the time proven patented construction of the 40 LW type enclosed in a silver case to provide ruggedness and then hermetically sealed using tantalum-to-glass seals.

OPERATING TEMPERATURE RANGE. The 40SW type is processed and constructed to withstand continuous operation at rated voltage from -55 C C to +85 C, and with proper derating, to 125 C. See Table 1.

D.C. WORKING VOLTAGE. The D.C. working voltage is the maximum operating voltage for continuous duty at the rated temperature. See Table 1.

SURGE VOLTAGE. The surge voltage is the maximum voltage capacitors can withstand for short duration under any conditions. This includes transients and peak ripple at the highest line voltage. See Table 1.

TABLE I

Operating 55 C to 85 C	Surge -55 C to 85 C	Operating 85 C to 125 C	Operating 125 C	Surge 125 C
6	6.9	Linear derating	4	4.6
8	9.2	applies from 85 C	5	5.7
10	11.5	operating voltage	7	8.0
15	17.2	shown to 125 C	10	11.5
20	23.0	operating voltage	13	15.0
25	28.8	shown.	15	17.2
30	34.5		20	23.0
35	40.2		24	28.0
50	57.5		30	34.5
60	69.0		40	46.0
75	86.2		50	57.2
100	115		70	80.5
125	144		85	97.5

CAPACITANCE. Capacitance measurements shall be made at 120 Hz with 1.0 VRMS max. and 2.2 VDC max. applied at a temperature of 25 C.

CAPACITANCE TOLERANCE. 40SW type capacitors are available in ±20%, ±10% and ±5% tolerance.

DISSIPATION FACTOR. Measurements shall be made by the bridge method at a frequency of 120 Hz with 1.0 VRMS max. and 2.2 VDC max. applied at a temperature of 25°C. Values shall not exceed those shown for each rating shown in table.

LEAKAGE CURRENT. Measurements shall be made at rated working voltage at 25 C ±5 with an application of a steady source of power, such as a regulated power supply with a 1000 ohm resistance to limit the charging current, connected in series with each capacitor under test. Rated working voltage shall be applied to capacitors for 5 minutes before making leakage current measurements.

IMPEDANCE. The impedance of any capacitor, at -55 C and 120 Hz, shall not exceed the values given in the table for each capacitor.

HIGH FREQUENCY VIBRATION. Capacitors shall withstand vibration from 10 to 2000 cycles at 20g without internal damage. Electrical measurements made while under these conditions shall show no intermittent open or short circuit.

Capacitors shall be securely fastened by means of suitable component clips or brackets.

LEAD PULL AND BEND TEST. Leads shall withstand a tensile stress of 3 pounds applied axially for 30 seconds. Leads shall meet the bend test requirement of Mil-C-39006.

MOISTURE RESISTANCE. Capacitors shall withstand the moisture resistance cycling test specified in MIL Standard 202C, Method 106A, without departure from the original limits of capacitance, equivalent series resistance and leakage current.

SHELF TEST. Capacitors shall withstand a 2000 hour shelf test at 125 C with no voltage applied.

Following the shelf test, the capacitance shall not have changed by more than ±5% from the initial value and the leakage current and equivalent series resistance shall not exceed the values given in the table for each capacitor.

THERMAL SHOCK AND IMMERSION. Capacitors shall withstand the thermal shock immersion tests specified in MIL Standard 202C, Method 107, test condition B, except that the low temperature shall be -55 C and Method 104A, test condition B, respectively, without departure from the original limits for capacitance, equivalent series resistance and leakage current.

REDUCED PRESSURE. Capacitors shall be stabilized at a reduced atmospheric pressure of 1.69 X 10^{-1} Torr. for a period of 5 minutes. Rated dc voltage shall be applied for 1 minute. Capacitors shall not flash over nor shall end seals be damaged by this test nor should the capacitors be electrically effected insofar as capacitance, equivalent series resistance, or leakage current is concerned.

SEAL TEST. Capacitors shall withstand 5 temperature altitude cycles without showing evidence of electrolyte leakage when checked with electrolyte indicating thymol blue dye. Each cycle shall consist of a 60 minute exposure at -55°C with the last 30 minutes at 1.69 X 10^{-1} Torr. and a 60 minute exposure to +125°C with the last 30 minutes at 1.69 X 10^{-1} Torr.

MARKING

Capacitors will be marked with Philips Components part marking Type SW, rated capacitance and tolerance, rated dc voltage and date code where space permits.

APPLICATION NOTES

The 40 SW type exceeds the requirements of MIL-C-39006 and can be used as direct replacement for these types where Mil Spec QPL product is NOT required.

The 40SW type utilizes the basic time proven integral seal of the 40LW tantalum capacitors covered by a hermetic tantalum-to-glass seal. This will enable the 40SW type to operate under extreme conditions of altitude (150,000 ft.) or pressure (26,000 lbs./IN) without seal damage or evidence of electrolyte leakage.

CONSULT THE PHILIPS COMPONENTS SALES DEPARTMENT FOR ENGINEERING ASSISTANCE ON THE FOLLOWING:

NON STANDARD RATINGS. Ratings and electrical limits other than those shown in the tables are available on special request.

EXTREME TEMPERATURES. Under special conditions the 40SW type may be operated or stored at temperatures exceeding the specified range.

SERIES 40SW

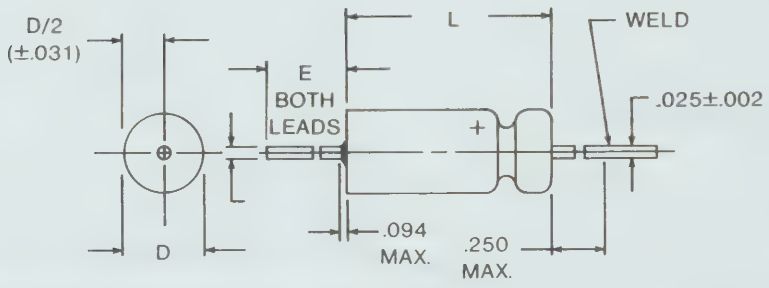
Industrial Type Tantalum Capacitors

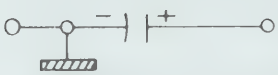
TANTALUM-TO-GLASS HERMETIC SEAL • FOR 125°C APPLICATIONS

PART NUMBER SYSTEM

EXAMPLE 4 0 S W 225 A 070 K 1 A

- A — INDUSTRIAL
- 1 — 0 = UNSLEEVED, 1 = SLEEVED
- K — CAPACITANCE TOLERANCE: J = ±5% K = ±10% M = ±20%
- 070 — VOLTAGE RATING @ 85 C
- A — CASE SIZE
- 225 — CAPACITANCE IN PICOFARADS
  First two digits are significant figures
  Third digit number of zeros to follow.
  255 = 2.5 uF
  256 = 25 uF
- W — WET ELECTROLYTE
- S — SERIES
- 0 — AXIAL LEAD
- 4 — TANTALUM CAPACITOR





CIRCUIT DIAGRAM

Case Size	DIMENSIONS FOR 40SW TYPE–INCHES (mm)						Approximate Weight (Grams)
	Uninsulated		Insulated		Lead Dia.	Lead Length	
	D ±0.016 (±0.41)	L + 0.031(0.79) L −0.016 (0.41)	D Max	L Max	D ±.002 (0.05)	E ±0.25 (±6.35)	
A	0.188 (4.8)	0.453 (11.5)	0.219 (5.6)	0.515 (13.1)	0.025 (0.64)	1.50 (38.10)	1.2 GRAM
B	0.281 (7.1)	0.641 (16.3)	0.313 (7.9)	0.703 (17.8)	0.025 (0.64)	2.25 (57.15)	3.1 GRAM
C	0.375 (9.5)	0.766 (19.5)	0.406 (10.3)	0.828 (21.0)	0.025 (0.64)	2.25 (57.15)	5.8 GRAM
D	0.375 (9.5)	1.062 (27.0)	0.406 (10.3)	1.124 (28.6)	0.025 (0.64)	2.25 (57.15)	9.0 GRAM

SERIES 40SW

Industrial Type Tantalum Capacitors

Case Size	uF	WVDC at 85°C	Max. D.F. at 25°C %	Max. Ω Impedance at −55°C	Max uA DC Leakage		Max. Capacitance Change in Percent			Part Number ±10%
					+25°C	+85°C	−55°C	+85°C	+125°C	
A	30	6	9.1	100	1.0	2.0	−40	+10.5	+12	40SW306A006K1A
A	68	6	20.4	59	1.0	2.0	−35	+13	+16	40SW686A006K1A
B	140	6	21.3	40	1.0	3.0	−40	+14	+16	40SW147B006K1A
B	270	6	81.8	25	1.0	6.5	−44	+17.5	+20	40SW277B006K1A
C	330	6	49.6	20	2.0	7.9	−44	+14	+16	40SW377C006K1A
C	560	6	128.0	25	2.0	13.0	−64	+17.5	+20	40SW567C006K1A
D	1200	6	144.4	15	3.0	14.0	−80	+20	+25	40SW128D006K1A
A	25	8	7.6	100	1.0	2.0	−40	+10.5	+12	40SW256A008K1A
A	56	8	17.0	59	1.0	2.0	−40	+14	+16	40SW566A008K1A
B	220	8	66.4	30	1.0	7.0	−44	+17.5	+20	40SW227B008K1A
C	430	8	91.5	25	2.0	14.0	−64	+17.5	+20	40SW437C008K1A
D	850	8	65.8	20	4.0	16.0	−80	+17.5	+25	40SW857D008K1A
A	20	10	6.1	120	1.0	2.0	−32	+10.5	+12	40SW206A010K1A
A	47	10	18.1	100	1.0	2.0	−36	+14	+16	40SW476A010K1A
B	100	10	15.2	60	1.0	4.0	−36	+14	+16	40SW107B010K1A
B	180	10	54.4	40	1.0	7.0	−36	+14	+16	40SW187B010K1A
C	250	10	37.8	30	2.0	10.0	−40	+14	+16	40SW257C010K1A
C	390	10	87.6	25	2.0	16.0	−64	+17.5	+20	40SW397C010K1A
D	750	10	56.5	23	4.0	16.0	−80	+17.5	+25	40SW757D010K1A
A	15	15	5.7	145	1.0	2.0	−24	+10.5	+12	40SW156A015K1A
A	33	15	12.5	90	1.0	2.0	−28	+14	+16	40SW336A015K1A
B	70	15	13.1	63	1.0	4.0	−28	+14	+16	40SW706B015K1A
B	120	15	36.8	50	1.0	7.0	−28	+17.5	+20	40SW127B015K1A
C	170	15	25.4	35	2.0	10.0	−32	+14	+16	40SW177C015K1A
C	270	15	60.9	30	2.0	16.0	−56	+17.5	+20	40SW277C015K1A
D	540	15	49.0	23	6.0	24.0	−80	+17.5	+25	40SW547D015K1A
A	10	25	6.0	190	1.0	2.0	−16	+ 8	+ 9	40SW106A025K1A
A	22	25	11.8	140	1.0	9.0	−20	+10.5	+12	40SW226A025K1A
B	100	25	31.4	50	1.0	8.0	−28	+13	+15	40SW107B025K1A
C	180	25	54.3	32	2.0	10.0	−48	+13	+15	40SW187C025K1A
D	350	25	35.0	24	7.0	28.0	−70	+13	+15	40SW357D025K1A
A	8	30	4.5	235	1.0	2.0	−16	+ 8	+12	40SW805A030K1A
A	15	30	9.1	175	1.0	2.0	−20	+10.5	+12	40SW156A030K1A
B	40	30	12.2	65	1.0	5.0	−24	+10.5	+12	40SW406B030K1A
B	68	30	31.0	60	1.0	9.0	−24	+13	+15	40SW686B030K1A
C	100	30	19.0	40	2.0	12.0	−28	+10.5	+12	40SW107C030K1A
C	150	30	46.0	40	3.0	16.0	−50	+13	+16	40SW157C030K1A
D	300	30	35.0	25	8.0	32.0	−60	+17.5	+20	40SW307D030K1A

SERIES 40SW
Industrial Type Tantalum Capacitors

Case Size	uF	WVDC at 85°C	Max. D.F. at 25°C %	Max. Ω Impedance at −55°C	Max uA DC Leakage		Max. Capacitance Change in Percent			Part Number ±10%
					+25°C	+85°C	55°C	+85°C	+125°C	
A	5	50	3.4	355	1.0	2.0	−16	+ 5	+ 6	40SW505A050K1A
A	10	50	6.0	250	1.0	2.0	−24	+ 8	+ 9	40SW106A050K1A
B	25	50	11.2	90	1.0	5.0	−20	+10.5	+12	40SW256B050K1A
B	47	50	21.4	70	1.0	9.0	−28	+13	+15	40SW476B050K1A
C	60	50	13.6	45	2.0	12.0	−16	+10.5	+12	40SW606C050K1A
C	82	50	24.9	45	2.0	16.0	−32	+13	+15	40SW826C050K1A
D	160	50	25.7	27	8.0	32.0	−50	+17.5	+20	40SW167D050K1A
A	4	60	3.0	405	1.0	2.0	−16	+ 5	+ 6	40SW405A060K1A
A	8.2	60	5.0	275	1.0	2.0	−24	+ 8	+ 9	40SW825A060K1A
B	20	60	7.6	105	1.0	5.0	−16	+10.5	+12	40SW206B060K1A
B	39	60	20.7	90	1.0	9.0	−28	+10.5	+12	40SW396B060K1A
C	50	60	15.3	50	2.0	12.0	−16	+10.5	+12	40SW506C060K1A
C	68	60	20.7	50	2.0	16.0	−32	+10.5	+12	40SW686C060K1A
D	140	60	25.7	28	8.0	32.0	−40	+17.5	+20	40SW147D050K1A
A	3.5	75	2.5	505	1.0	2.0	−16	+ 5	+ 6	40SW355A075K1A
A	16.8	75	4.1	300	1.0	2.0	−20	+ 8	+ 9	40SW685A075K1A
B	15	75	7.5	135	1.0	5.0	−16	+ 8	+ 9	40SW156B075K1A
B	33	75	17.5	90	1.0	10.0	−24	+10.5	+15	40SW336B075K1A
C	40	75	15.2	60	2.0	12.0	−16	+10.5	+12	40SW406C075K1A
C	56	75	26.0	60	2.0	17.0	−28	+10.5	+15	40SW566C075K1A
D	110	75	25.7	29	9.0	36.0	−35	+17.5	+20	40SW117D075K1A
A	2.5	100	5.0	710	1.0	2.0	−16	+ 7	+ 8	40SW255A100K1A
A	14.7	100	3.6	500	1.0	2.0	−16	+ 7	+ 8	40SW475A100K1A
B	11	100	5.0	200	1.0	4.0	−16	+ 7	+ 8	40SW116B100K1A
B	22	100	11.8	100	1.0	9.0	−16	+ 7	+ 8	40SW226B100K1A
C	30	100	9.1	80	2.0	12.0	−16	+ 7	+ 8	40SW306C100K1A
C	43	100	19.7	70	2.0	17.0	−20	+ 7	+ 8	40SW436C100K1A
D	86	100	20.7	30	9.0	36.0	−25	+12.5	+15	40SW866D100K1A
A	1.7	125	7.0	1250	1.0	2.0	−16	+ 7	+ 8	40SW175A125K1A
A	3.6	125	4.1	600	1.0	2.0	−16	+ 7	+ 8	40SW365A125K1A
B	9	125	10.2	220	1.0	5.0	−16	+ 7	+ 8	40SW905B125K1A
B	14	125	12.7	167	1.0	7.0	−16	+ 7	+ 8	40SW146B125K1A
C	18	125	15.0	135	2.0	9.0	−15	+ 7	+ 8	40SW186C125K1A
C	25	125	19.0	93	2.0	13.0	−16	+ 7	+ 8	40SW256C125K1A
D	56	125	18.5	32	10.0	40.0	−20	+12	+15	40SW566D125K1A

SERIES 40TW

Tantalum Case Hermetically Sealed Tubular Tantalum Wet-Slug Capacitor

−55°C to 200°C 1.7 to 1200 μF
4-125 Volts DC

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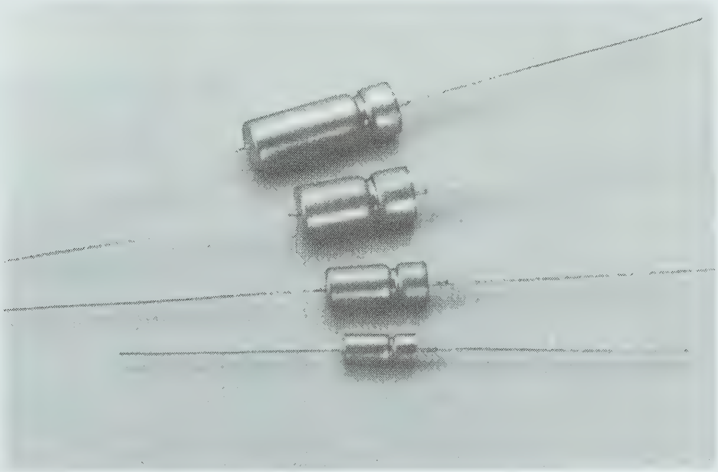
Tantalum Capacitors



DESCRIPTION

The 40TW capacitor is an all tantalum cased high reliability porous anode type with a glass to tantalum hermetic seal. This type capacitor is primarily suited for military and aerospace application. This capacitor meets or exceeds all requirements of MIL-C-39006/22.

These capacitors are ideal for such functions as filtering, by-passing, coupling and timing in applications where minimum size and weight conditions must be achieved and reverse voltage up to 3VDC, or high ripple currents, are required.

GLASS-TO-TANTALUM SEAL

The glass-to-tantalum seal is one unique feature of the 40TW Series. This seal differs from other hermetic seals in that it is a tantalum feed-through seal. This construction provides a true glass-to-tantlum seal.

WARNING
NON-SOLID ELECTROLYTIC CAPACITORS MAY CONTAIN CHEMICALS WHICH CAN BE REGARDED AS HAZARDOUS IF HANDLED INCORRECTLY. CAUTION IS NECESSARY IF THE OUTER CASE IS FRACTURED.

TANTALUM CASE

Use of a tantalum case and tantalum powder cathode permits 3VDC reverse capability without harm; and the sintered powder cathode allows higher vibration and shock levels than comparable silver cased devices.

FEATURES

- All tantalum construction
- Reverse voltage capability of 3VDC
- High ripple current
- Long life
- Derated for 200°C operation

SERIES 40TW

Industrial Type Tantalum Capacitors

DIMENSIONS

OUTLINE DRAWING

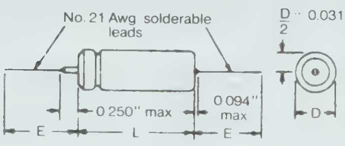


FIG 1 UNINSULATED

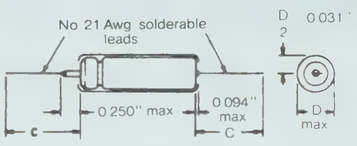


FIG 2 INSULATED

OUTLINE DIMENSIONS

Case Code		Dimensions — Inches (mm)				
		Basic case		Insulated case		
Type 40TW	MIL Equiv.	L* .031 (.79) .016 (.41)	D .016 (.41)	D max	E .250 (6.35)	d .002 (.05)
A	T1	453 (11.51)	188 (4.78)	.219 (5.56)	1.500 (38.10)	.025 (64)
B	T2	.641 (16.28)	281 (7.14)	.312 (7.92)	2.250 (57.15)	.025 (64)
C	T3	.766 (19.46)	.375 (9.53)	406 (10.31)	2.250 (57.15)	.025 (64)
D	T4	1 062 (26 97)	375 (9 53)	406 (10.31)	2 250 (57.15)	025 (64)

*Length of basic case; sleeving shall lap over the ends of the capacitor body Non-shrinkab sleeving extends 016 inch minimum, 062 inch maximum beyond each end of the case

STANDARD RATINGS

μF	Case Code	Catalog Number*	Max. DF at 25°C and 120 Hz %	Max. Impedance at −55°C and 120 Hz (Ω)	Max. D-C Leakage Current at 25°C (μA)	Max. D-C Leakage Current at 85°C & 125°C (μA)	Maximum Capacitance Change in Percent at −55°C	+85°C	+125°C	Max. RMS Ripple Current At 40 KHz (mA)
6 VOLTS D-C AT 85°C, 4 VOLTS D-C AT 125°C										
30	A	40TW306A006KIA	9	100	1.0	1.5	40	10 5	12	820
68	A	40TW686A006KIA	15	60	1.0	1 5	- 40	14	16	960
140	B	40TW147B006KIA	21	40	1.0	2 0	40	14	16	1200
270	B	40TW277B006KIA	45	25	1 0	2 0	44	12 5	20	1375
330	C	40TW337C006KIA	36	20	2.0	6 0	44	14	16	1800
560	C	40TW567C006KIA	55	25	2.0	6 0	- 64	17 5	20	1900
1200	D	40TW128D006KIA	90	20	3.0	12 0	80	25	25	2265
8 VOLTS D-C AT 85°C, 5 VOLTS D-C AT 125°C										
25	A	40TW256A008KIA	7 5	100	1.0	1 5	- 40	10 5	12	820
56	A	40TW566A008KIA	14	59	1 0	1 5	− 40	14	16	900
120	B	40TW127B008KIA	20	50	1 0	2 0	− 44	17 5	20	1220
220	B	40TW227B008KIA	40	30	1.0	2 0	44	17 5	20	1370
290	C	40TW297C008KIA	40	25	2.0	6 0	64	17 5	20	1770
430	C	40TW437C008KIA	46	25	2.0	6 0	64	17 5	20	1825
850	D	40TW857D008KIA	60	22	3 0	12 0	80	25	25	2330
10 VOLTS D-C AT 85°C, 7 VOLTS D-C AT 125°C										
20	A	40TW206A010KIA	6	120	1.0	1 5	32	10 5	12	820
47	A	40TW476A010KIA	13	90	1 0	1 5	- 36	14	16	855
100	B	40TW107B010KIA	15	60	1.0	2 0	36	16	16	1200
180	P	40TW187B010KIA	33	40	1.0	2 0	36	14	16	1365
250	C	40TW257C010KIA	30	30	2.0	6 0	− 40	14	16	1720
390	C	40TW397C010KIA	44	25	2 0	6 0	64	17 5	20	1800
750	D	40TW757D010KIA	50	23	3 0	12 0	− 80	25	25	2360
15 VOLTS D-C AT 85°C, 10 VOLTS D-C AT 125°C										
15	A	40TW156A015KIA	5	155	1.0	1 5	24	10 5	12	780
33	A	40TW336A015KIA	10	90	1.0	1 5	− 28	14	16	820
70	B	40TW706B015KIA	13	75	1.0	2 0	− 28	14	16	1150
120	B	40TW127B015KIA	25	50	1.0	2 0	− 28	17 5	20	1450
170	C	40TW177C015KIA	25	35	2.0	6 0	− 32	14	16	1480
270	C	40TW277C015KIA	43	30	2.0	6 0	56	17 5	20	1740
540	D	40TW547D015KIA	40	23	3.0	12 0	80	25	25	2300
25 VOLTS D-C AT 85°C, 15 VOLTS D-C AT 125°C										
10	A	40TW106A025KIA	4	220	1.0	1 5	16	8	9	715
22	A	40TW226A025KIA	7	140	1.0	1 5	20	10 5	12	825
50	B	40TW506B025KIA	11	70	1.0	2 0	28	13	15	1130
100	B	40TW107B025KIA	21	50	1.0	2 0	28	13	15	1435
120	C	40TW127C025KIA	25	38	2.0	6 0	32	13	15	1450
180	C	40TW187C025KIA	28	32	2.0	6 0	48	13	15	1525
350	D	40TW357D025KIA	35	24	3.0	12 0	70	25	25	1970

SERIES 40TW

Industrial Type Tantalum Capacitors

μF	Case Code	Catalog Number *	Max. DF at 25°C and 120 Hz %	Max. Impedance at −55°C and 120 Hz (Ω)	Max. D-C Leakage Current at 25°C (μA)	Max. D-C Leakage Current at 85°C & 125°C (μA)	Maximum Capacitance Change in Percent at −55°C	+85°C	+125°C	Max. RMS Ripple Current At 40 KHz (mA)
		30 VOLTS D-C AT 85°C, 20 VOLTS D-C AT 125°C								
8	A	40TW805A030KIA	4	275	1.0	1.5	−16	8	12	640
15	A	40TW156A030KIA	7	175	1.0	1.5	20	10.5	12	780
40	B	40TW406B030KIA	12	65	1.0	2.0	−24	10.5	12	1120
68	B	40TW686B030KIA	15	60	1.0	2.0	−24	13	15	1285
00	C	40TW107C030KIA	17	40	2.0	6.0	−28	10.5	12	1450
50	C	40TW157C030KIA	23	35	2.0	6.0	−48	13	15	1525
00	D	40TW307D030KIA	31	25	3.0	12.0	60	25	25	1950
		50 VOLTS D-C AT 85°C, 30 VOLTS D-C AT 125°C								
5	A	40TW505A050KIA	3	400	1.0	2.0	−16	5	6	580
10	A	40TW106A050KIA	5	250	1.0	2.0	24	8	9	715
25	B	40TW256B050KIA	9	95	1.0	3.0	−20	10.5	12	1005
47	B	40TW476B050KIA	13	70	1.0	3.0	−28	13	15	1155
60	C	40TW606C050KIA	13	45	2.0	7.0	16	10.5	12	1335
82	C	40TW826C050KIA	15	45	2.0	7.0	32	13	15	1400
60	D	40TW167D050KIA	17	27	4.0	16.0	−50	25	25	1900
		60 VOLTS D-C AT 85°C, 40 VOLTS D-C AT 125°C								
4	A	40TW405A060KIA	2.8	550	1.0	2.0	16	5	6	525
8.2	A	40TW825A060KIA	4	275	1.0	2.0	24	8	9	625
20	B	40TW206B060KIA	7	105	1.0	4.0	16	8	9	930
39	B	40TW396B060KIA	12	90	1.0	4.0	−28	10.5	15	1110
50	C	40TW506C060KIA	11	50	2.0	7.0	−16	10.5	12	1330
68	C	40TW686C060KIA	13	50	2.0	7.0	32	10.5	15	1365
40	D	40TW147D060KIA	16	28	4.0	16.0	−40	20	20	1850
		75 VOLTS D-C AT 85°C, 50 VOLTS D-C AT 125°C								
3.5	A	40TW355A075KIA	2.5	650	1.0	2.0	−16	5	6	525
6.8	A	40TW685A075KIA	3.5	300	1.0	2.0	20	8	9	610
15	B	40TW156B075KIA	6	150	1.0	4.0	−16	8	9	890
33	B	40TW336B075KIA	10	90	1.0	4.0	24	10.5	15	1000
40	C	40TW406C075KIA	9	60	2.0	8.0	16	10.5	12	1250
56	C	40TW566C075KIA	11	60	2.0	8.0	−28	10.5	15	1335
10	D	40TW117D075KIA	12	29	4.0	20.0	35	20	20	1850
		100 VOLTS D-C AT 85°C, 65 VOLTS D-C AT 125°C								
2.5	A	40TW255A100KIA	2	950	1.0	2.0	−16	7	8	505
4.7	A	40TW475A100KIA	3	500	1.0	2.0	−16	7	8	565
11	B	40TW116B100KIA	5	200	1.0	4.0	−16	8	8	835
22	B	40TW226B100KIA	8	100	1.0	4.0	−16	8	8	965
30	C	40TW306C100KIA	7.5	80	2.0	8.0	16	8	8	1240
43	C	40TW436C100KIA	8.5	70	2.0	8.0	−20	8	8	1335
86	D	40TW866D100KIA	10	30	4.0	20.0	−25	15	15	1800
		125 VOLTS D-C AT 85°C, 85 VOLTS D-C AT 125°C								
1.7	A	40TW175A125KIA	2	1250	1.0	2.0	16	7	8	415
3.6	A	40TW365A125KIA	3	600	1.0	2.0	−16	7	8	520
9	B	40TW905B125KIA	5	240	1.0	4.0	−16	7	8	755
14	B	40TW146B125KIA	6	167	1.0	4.0	16	7	8	860
18	C	40TW186C125KIA	5	129	2.0	8.0	16	7	8	1130
25	C	40TW256C125KIA	6	93	2.0	8.0	−16	7	8	1200
56	D	40TW566D125KIA	6.5	32	4.0	20.0	−25	15	15	1800

talog numbers listed are for ±10% capacitance tolerance and are for insulated capacitors.

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Tantalum Capacitors

SERIES 40TW
Industrial Type Tantalum Capacitors

PERFORMANCE CHARACTERISTICS

1. Operating Temperature Range. These capacitors are designed to operate over a temperature range of −55°C to +125°C/200°C at the appropriate voltage rating given in Para. 17.

2. DC Working Voltage. The dc working voltage is the maximum operating voltage for continuous duty at the rated temperature.

Up to 85°C	125°C	175°C	200°C
6	4	*	*
8	5	*	*
10	7	*	*
15	10	*	*
25	15	*	*
30	20	*	*
50	30	*	*
60	40	*	*
75	50	*	*
100	65	*	*
125	85	*	*

*Ref. Paragraph 17 for the derating percentages and the associated life test.

3. DC Leakage Current. Measurements shall be made at the applicable rated working voltage at 25°C ±5°C through application of a steady source of power, such as a regulated power supply. A current limiting resistor of 1000 ohms shall be connected in series with each capacitor under test. Rated DC working voltage shall be applied for a maximum period of 5 minutes before making leaking current measurements.

3.1 The maximum leakage current values are as listed in the standard ratings table.

4. Capacitance and Tolerance. The capacitance of all capacitors shall be within the specified tolerance limits of the nominal rating.

4.1 Measurements shall be made by the bridge method at or referred to a frequency of 120 Hz at a temperature of +25°C. The maximum voltage applied to the capacitors during measurements shall be 1 volt rms. Measurement accuracy of the bridge shall be within ±2%.

5. Dissipation Factor. Measurements are made with a polarized capacitance bridge at a frequency of 120 Hz at a temperature of +25°C.

6. Capacitance Change with Temperature. Capacitance change with temperature shall not exceed the limits given in the standard ratings table.

7. Low Temperature Impedance. The impedance of any capacitor at −55°C at 120 Hz shall not exceed the values given in the standard ratings table.

8. Mechanical Shock. Capacitors shall withstand a shock of 100g when tested in accordance with method 213 of Military Standard MIL-STD-202, test condition I.

8.1 Following the shock test, capacitors shall be examined for evidence of mechanical damage and leakage of electrolyte.

9. High Frequency Vibration. Capacitors shall withstand vibration from 10 to 2000 Hz at 20g without internal damage when tested in accordance with Military Standard MIL-STD-202, method 204, test condition D. Electrical measurements made while under these conditions shall show no intermittent contacts or open or short circuiting.

9.1 Following the vibration test, the dc leakage current shall not exceed 125% of the original requirement; the capacitance shall change not more than ±5% from the initial measured value and the DF shall not exceed 115% of initial requirement.

9.2 In addition, there shall be no evidence of mechanical damage, obliteration of marking, or leakage of electrolyte.

10. Pull Test. Leads shall withstand a tensile stress of 3 lbs. for 30 seconds applied axially in accordance with MIL-STD-202, method 211 test condition A.

11. Lead Bend Test. Leads shall meet the bend test specified in MIL-STD-202, method 211 test condition C except that the number of bends shall be 4.

12. Surge Voltage. The surge voltage rating is the maximum voltage to which the capacitors shall be subjected under any conditions. This includes transients and peak ripple at the highest line voltage. The surge voltage of these capacitors is 115% of rated dc working voltage.

12.1 The capacitors shall withstand the surge voltage applied through a 1000 ohm ±10% resistor in series with the capacitor and voltage source at the rate of ½ minute on, 4½ minutes off, for 1000 successive test cycles at 85°C.

12.2 Following the surge voltage test, there shall be no intermittent contacts, open or short circuiting, mechanical damage, or leakage of electrolyte.

13. Moisture Resistance. Capacitors shall be subjected to the moisture resistance cycling test specified in MIL-STD-202, method 106.

PERFORMANCE CHARACTERISTICS

13.1 Following the moisture resistance test, the dc leakage current shall not exceed 125% of the original requirement; the capacitance shall change not more than ±8% from the initial measured value and the DF shall not exceed 115% of initial requirement.

14. Seal Test. Capacitors shall be tested in accordance with MIL-STD-202, method 112, test condition C, procedure IIIa, 10^{-8} atm cc/sec followed by test condition A.

15. Reverse Voltage Test. Capacitors shall be subjected to a dc potential of 3 volts, applied in the reverse polarity direction, for 125 ±10 hours. The ambient temperature during the test shall be +85°C. Capacitors shall be maintained at +85°C and dc rated voltage shall be applied in the forward direction for an additional period of 125 ±10 hours.

15.1 Following the reverse voltage testing, the dc leakage current shall not exceed 125% of the original requirement; the capacitance shall be within the initial value specified and the DF shall not exceed the original requirements.

16. Ripple Life Test at +85°C. Capacitors shall be tested in accordance with Military Specification MIL-C-39006. a. Operating Conditions. This test shall be run at a frequency of 40 KHz ± 2 KHz and at the rms ripple current levels specified in the standard ratings table. b. Applied dc voltage plus the peak a-c voltage shall not exceed the rated voltage of the capacitor.

16.1 When tested as specified above, capacitors shall meet the following requirements: a. The dc leakage current at +25°C and at +85°C shall not exceed the original requirements. b. The capacitance shall not change more than ±10% from the initial measured value. c. The DF shall not exceed the original requirements. d. Visual examination. There shall be no damage, obliteration of marking, or leakage of electrolyte.

17. Life Test. Capacitors are capable of withstanding life test at the following conditions:

Temperature	Hrs.	% Rated Voltage
+85°C	2000	100*
+125°C	2000	100*
+175°C	2000	50
+175°C	300	65
+200°C	300	60

*Refer to the standard ratings table.

17.1 After life test and for those tested at +85 and/or +125°C, the capacitors shall be returned to +25°C ±5°C. The dc leakage current, measured at +25°C, +85 and/or +125°C, shall not exceed the initial requirement; the DF shall not exceed the initial requirement; and the capacitance value shall not change more than 10% from the initial measurement.

17.2 After life test and for those tested at +175°C and +200°C, the capacitor shall be returned to +25°C ±5°C. The dc leakage current at the rated voltage shall not exceed 200% of the original requirement or ±10 ua, whichever is greater; the DF shall not be greater than 200% of the original requirement; and the capacitance value shall not increase by more than 10% or decrease by more than 20% from the initial requirement.

17.3 Not more than 1 failure shall be permitted in 12 units tested.

18. Barometric Pressure (reduced). Capacitors shall be tested in accordance with MIL-STD-202, method 105, test condition E. Rated dc voltage shall be applied for 1 minute ±5 seconds.

18.1 Following Barometric Pressure test, capacitors shall be visually examined for harmful deformation of the case, mechanical damage, obliteration of marking, leakage of electrolyte and indications of flashover and breakdown.

19. Thermal Shock. Capacitors shall be subjected to 300 cycles in accordance with MIL-STD-202, method 107 and MIL-C-39006.

19.1 Following the thermal shock test, dc leakage current shall not exceed 200% of the initial requirement, capacitance shall not have changed more than ±5% from initial measured value and DF shall not exceed 115% of initial specified value.

20. Marking. Capacitors shall be marked with Philips Components part marking number (TW), rated capacitance and tolerance, rated dc working voltage and the standard Eia Date code of manufacture

21. Polarity. Polarity shall be indicated by plus (+) signs adjacent to the positive terminal.

22. Insulation. When an insulated device is required, the insulating material will be KAPTON.

SERIES 40TW

Industrial Type Tantalum Capacitors

RIPPLE CURRENT MULTIPLIERS VS. FREQUENCY, TEMPERATURE & APPLIED PEAK VOLTAGE

Frequency of applied ripple current		120 Hz				800 Hz				1 kHz				10 kHz				40 kHz				100 kHz			
		Temp °C				Temp °C				Temp °C				Temp °C				Temp °C				Temp °C			
Ambient still air		55°	85°	105°	125°	55°	85°	105°	125°	55°	85°	105°	125°	55°	85°	105°	125°	55°	85°	105°	125°	55°	85°	105°	12
peak voltage	100%	60	39	–	–	71	43	–	–	72	45			88	55			1 0	63			1 1	69		
	90	60	46			71	55			72	55			88	67			1 0	77			1 1	85		
	80	60	52	35		71	62	42		72	62	42		88	76	52		1 0	87	59		1 1	96	65	
	70	60	58	44		71	67	52		72	70	52		88	85	[illegible]		1 0	97	73		1 1	1 07	80	
	66 2/3	60	60	46	27	71	71	55	[illegible]	72	72	55	32	88	88	68	40	1 0	1 0	77	45	1 1	1 1	85	5

NOTES:
1 At 125°C the rated voltage of the capacitors decreases to 66-2/3% of the 85°C rated voltage
2 The peak of the applied ac ripple voltage plus the applied dc voltage must not exceed the dc voltage rating of the capacitor either forward or reverse
3 The ripple current listed in table I represents a rating calculated using a maximum internal temperature rise (△T) of 50°C at 40 kHz at 85°C ambient with a maximum peak rated voltage of 66-2 3% of the 85°C peak voltage rating
4 The maximum allowable internal temperature rise (△T) decreases linearly to a calculated 10°C rise at 125°C ambient
5 The internal temperature rise is directly proprotional to the ESR of the capacitor and ESR increases with decreasing frequency

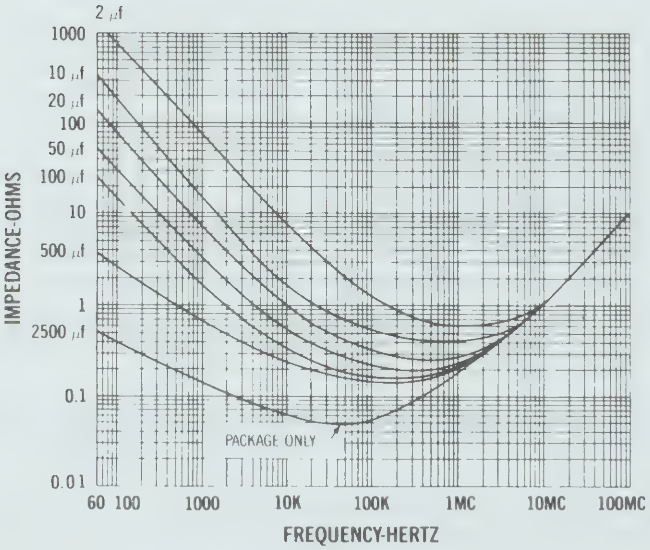
TYPICAL CURVES

Impedance

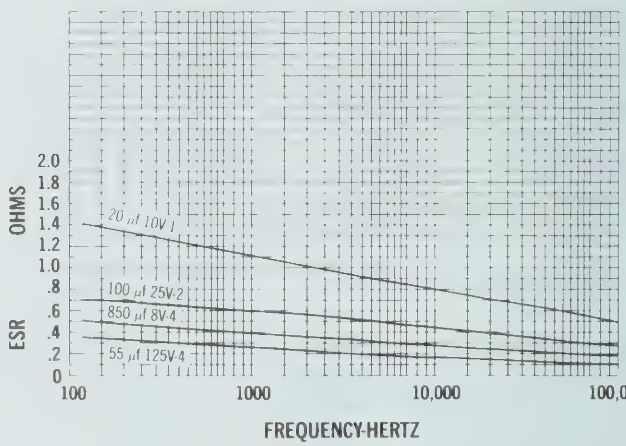
A. Impedance in ohms at 25°C may be read directly from Curve 1.

B. To obtain impedance at temperatures other than 25°C, multiply the impedance from Curve 1 by a correction factor from Curve 2, 3, or 4.

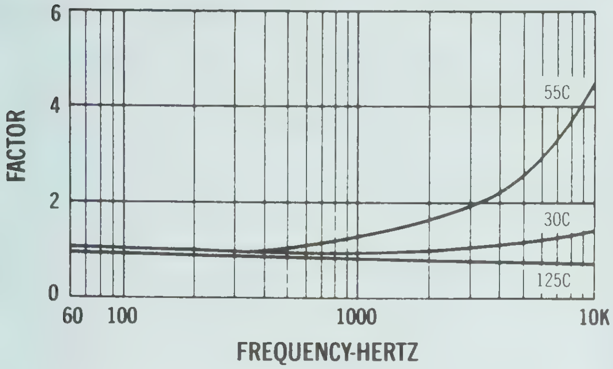
IMPEDANCE FOR TANTALUM WET SLUGS
AT 25°C
NO. 1



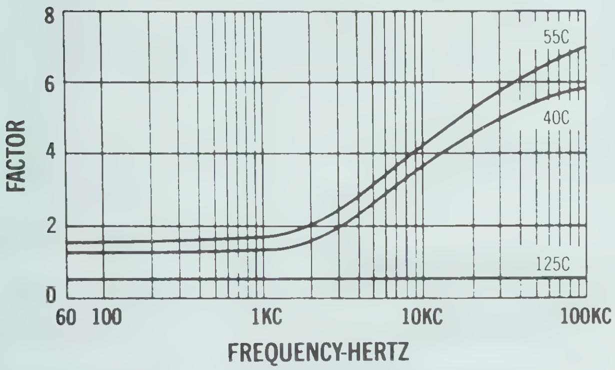
TYPICAL ESR VS. FREQUENCY AT 25°C



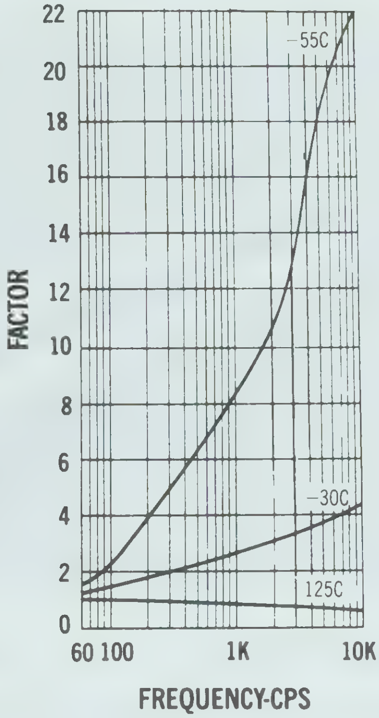
WET SLUG IMPEDANCE CORRECTION FACTORS
UP TO 5 μf
NO. 2



WET SLUG IMPEDANCE CORRECTION FACTORS
FOR CAPACITANCE 5-100 μf
NO. 3



WET SLUG IMPEDANCE CORRECTION FACTORS
FOR CAPACITANCE 100 μf
AND ABOVE INCLUDING PACKAGES
NO. 4



HOW TO SPECIFY

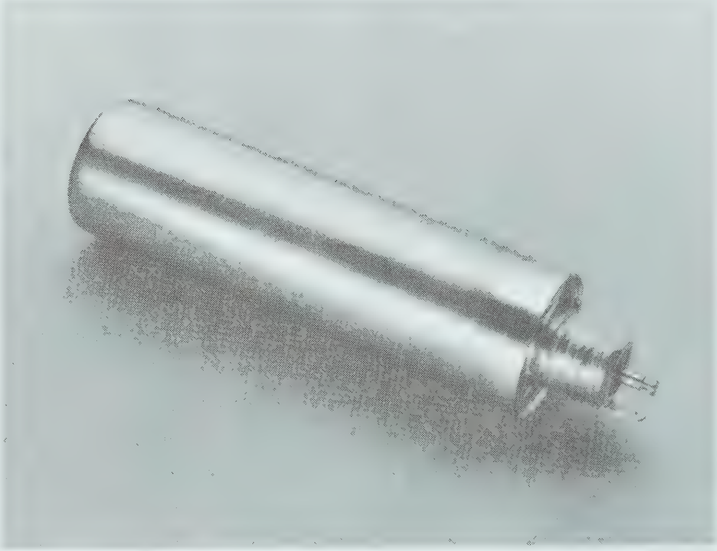
Series 40TW can be specified using the following designation:

4 0 T W 225 A 075 K I A

- **4** — Tantalum Capacitor
- **0** — Axial Lead
- **T** — Series
- **W** — Wet Slug
- **225** — Capacitance in (pF)
  First two digits are significant figures
  Third digit numbers of zeros to follow
  225 = 2.2μF
  226 = 22μF
- **A** — Case Size
- **075** — Voltage Rating @ 85°C
- **K** — Capacitance Tolerance
  J = ± 5%
  K = ±10%
  M = ±20%
- **I** — O = Unsleeved
  I = Sleeved
- **A** — Industrial

SERIES 43XW

Hermetic Cylindrical Case Tantalum Capacitor



3

Tantalum Capacitors

DESCRIPTION

Philips Components Series 43XW offer varied capacitance and voltage ratings and have the inherent electrical and physical environmental stability of the sintered anode-gelled electrolyte construction.

All 43XW Series capacitors are hermetically sealed and meet or exceed the requirements of Mil-C-3965 and Mil-C-39006.

Because of the rugged construction and extreme purity of the sintered tantalum anodes used in the capac`tor elements, the 43XW Series will operate reliably from −55°C to +125°C.

FEATURES

- MODULES
- HERMETICALLY SEALED
- +125°C OPERATION
- 20V TO 630V RATINGS
- 3.5 uf TO 1300 uf

WARNING
NON-SOLID ELECTROLYTIC CAPACITORS MAY CONTAIN CHEMICALS WHICH CAN BE REGARDED AS HAZARDOUS IF HANDLED INCORRECTLY. CAUTION IS NECESSARY IF THE OUTER CASE IS FRACTURED.

SERIES 43XW

Industrial Type Tantalum Capacitors

APPLICATIONS

REVERSE VOLTAGE

43XW capacitors are not recommended for circuits where reversals of any magnitude occur.

DERATED VOLTAGE OPERATION

Type 43XW may be operated at voltages less than the rated values designated. The reliability of operation increases, and long term degradation decreases.

SPECIAL RATINGS & CONFIGURATIONS

Many ratings of capacitance and voltage other than those shown are available.

All 43XW capacitors function with the case negative (ground) and glass sealed terminal as positive. Reverse ground configurations are available but will carry special part numbers.

For your special rating and configuration requirements, contact the Philips Components Sales Engineering Department.

VIBRATION

Capacitors shall withstand a simple harmonic motion having an amplitude of 0.03" (max. total excursion 0.06") with the frequency being varied uniformly between the approximate limits of 10 to 55 cycles and ratings to be transversed in approximately 1 minute for a total of 1½ hours.

Capacitors shall withstand vibration from 10 to 2000 cycles at 15G without internal damage. Electrical measurements made while under these conditions shall show no intermittent open or short circuit.

CASE INSULATION

When specifying case insulation, add 0.031" to the H and D dimensions

3

Tantalum Capacitors

GENERAL SPECIFICATIONS

OPERATING TEMPERATURE

Philips Components 43XW type tantalum capacitors are designed to operate over a temperature range of −55°C to +85°C without derating. Operation up to 125°C is also permissible with proper derating.

DC WORKING VOLTAGE

The DC working voltage is the maximum operating voltage for continuous duty at the rated temperature.

DC LEAKAGE

Measurements shall be made at rated working voltage with an application of a steady source of power, such as a regulated power supply with a 1000 ohm resistance to limit the charging current, connected in series with each capacitor under test. Rating working voltage shall be applied to capacitors for 5 minutes before making leakage current measurements.

CAPACITANCE

Will be measured by the bridge method with a 120 Hz 0.6 VRMS and 2.0 VDC bias applied.

SURGE VOLTAGE

The surge DC rating is the maximum voltage to which the capacitors should be subjected under any conditions. This includes transients and peak ripple at the highest line voltage. The surge voltage of all Philips Components 43XW type tantalum capacitors is 115% of rated DC working voltage.

-55° to 85°C		125°C
Rated	Surge	Rated
20	23	17.5
30	34.5	25
60	69	50
90	103	80
180	207	160
270	310	240
360	415	320
450	517	400
540	620	480
630	725	560

POWER FACTOR

Will be measured by the bridge method with a 120 Hz 0.6 VRMS and a 2.0 VDC bias applied.

IMPEDANCE

Measured at -55 with a 120 Hz signal. The value shall not exceed that specified in the table for each rating.

SERIES 43XW

Industrial Type Tantalum Capacitors

Cap (uF)	Volt	Size D +.031 -.015	Size H +.062	Max DF-120 Hz @ 25°C %	DC Leakage Current (Max) Microamperes 25°C	85°C	125°C	Impedance Ohms (Max) 120Hz -55 C	Maximum Capacitance Change Percent — Referenced to as 25 C -55°C	85°C	125°C	Part Number
100	20	875	540	21	10	50	75	30	-60	+15	+20	43XW107A020K0AE
		875	540	21	10	50	75	30	-60	+15	+20	43XW107A020K0AF
200	20	.875	.732	36	16	80	120	20	-60	+15	+20	43XW207B020K0AE
		875	732	36	16	80	120	20	-60	+15	+20	43XW207B020K0AF
75	30	.875	.540	15	11	55	82	45	-45	+15	+10	43XW756A030K0AE
		875	.540	15	11	55	82	45	-45	+15	+10	43XW756A030K0AF
150	30	.875	.732	29	13	90	135	30	-45	+15	+10	43XW157B030K0AE
		875	.732	29	13	90	135	30	-45	+15	+10	43XW157B030K0AF
370	30	1.125	.600	39	18	125	170	15	-65	+20	+25	43XW377P030K0AE
		1 125	.600	39	18	125	170	15	-65	+20	+25	43XW377P030K0AA
650	30	1.125	1.100	60	21	145	202	15	-85	+20	+25	43XW657R030K0AE
		1.125	1.100	60	21	145	202	15	-85	+20	+25	43XW657R030K0AA
1300	30	1.125	1.100	83	27	190	282	10	-85	+20	+25	43XW138R030K0AE
		1.125	1.100	83	27	190	282	10	-85	+20	+25	43XW138R030K0AA
40	60	.875	.540	8.2	12	60	90	65	-35	+10	+10	43XW406A060K0AE
		.875	.540	8.2	12	60	90	65	-35	+10	+10	43XW406A060K0AF
80	60	.875	.732	16	19	95	142	35	-35	+10	+10	43XW806B060K0AE
		.875	.732	16	19	95	142	35	-35	+10	+10	43XW806B060K0AF
200	60	1.125	.600	22	19	135	182	30	-50	+20	+25	43XW207P060K0AE
		1.125	.600	22	19	135	182	30	-50	+20	+25	43XW207P060K0AA
350	60	1.125	1 100	37	22	155	210	25	-70	+20	+25	43XW357R060K0AE
		1.125	1.100	37	22	155	210	25	-70	+20	+25	43XW357R060K0AA
700	60	1.125	1.100	62	29	200	275	15	-70	+20	+25	43XW707R060K0AE
		1.125	1.100	62	29	200	275	15	-70	+20	+25	43XW707R060K0AA
25	90	.875	.540	5.1	11	55	82	90	-35	+10	+10	43XW256A090K0AE
		.875	.540	5.1	11	55	82	90	-35	+10	+10	43XW256A090K0AF
50	90	.875	.732	10	18	90	135	45	-35	+10	+10	43XW506B090K0AE
		.875	.732	10	18	90	135	45	-35	+10	+10	43XW506B090K0AF
120	90	1.125	.600	13	19	135	182	40	-40	+20	+25	43XW127P090K0AE
		1.125	.600	13	19	135	182	40	-40	+20	+25	43XW127P090K0AA
220	90	1.125	1.100	24	21	145	202	30	-60	+20	+25	43XW227R090K0AE
		1 125	1.100	24	21	145	202	30	-60	+20	+25	43XW227R090K0AA
450	90	1.125	1.100	45	29	195	215	25	-60	+20	+25	43XW457R090K0AE
		1.125	1.100	45	29	195	215	25	-60	+20	+25	43XW457R090K0AA
12	180	.875	.920	5.1	11	55	82	180	-35	+10	+10	43XW126C180K0AE
		.875	.920	5.1	11	55	82	180	-35	+10	+10	43XW126C180K0AF
25	180	.875	1.300	10	18	90	135	90	-35	+10	+10	43XW256E180K0AE
		875	1.300	10	18	90	135	90	-35	+10	+10	43XW256E180K0AF
42	180	1.125	.976	10	18	90	135	90	-40	+20	+25	43XW426Q180K0AE
		1.125	.976	10	18	90	135	90	-40	+20	+25	43XW426Q180K0AA
60	180	1.125	976	13	19	135	182	60	-40	+20	+25	43XW606Q180K0AE
		1.125	.976	13	19	135	182	60	-40	+20	+25	43XW606Q180K0AA
110	180	1.125	1.938	24	21	145	202	60	-60	+20	+25	43XW117U180K0AE
		1.125	1.938	24	21	145	202	60	-60	+20	+25	43XW117U180K0AA
230	180	1.125	1.938	46	29	200	275	50	-60	+20	+25	43XW237U180K0AE
		1.125	1.938	46	29	200	275	50	-60	+20	+25	43XW237U180K0AA
8	270	.875	1.270	5.1	11	55	82	270	-35	+10	+10	43XW805D270K0AE
		875	1.270	5.1	11	55	82	270	-35	+10	+10	43XW805D270K0AF
16	270	.875	1.865	10	18	90	135	135	-35	+10	+10	43XW166G270K0AE
		875	1.865	10	18	90	135	135	-35	+10	+10	43XW166G270K0AF
28	270	1.125	1.350	16	19	120	162	80	-40	+20	+25	43XW286S270K0AE
		1.125	1.350	16	19	120	162	80	-40	+20	+25	43XW286S270K0AA
40	270	1.125	1.350	22	19	135	182	100	-40	+20	+25	43XW406S270K0AE
		1.125	1.350	22	19	135	182	100	-40	+20	+25	43XW406S270K0AA
75	270	1.125	2.812	24	21	145	202	90	-60	+20	+25	43XW756Y270K0AE
		1.125	2.812	24	21	145	202	90	-60	+20	+25	43XW756Y270K0AA
150	270	1.125	2.812	45	28	195	215	75	-60	+20	+25	43XW157Y270K0AE
		1.125	2.812	45	28	195	215	75	-60	+20	+25	43XW157Y270K0AA
6	360	.875	1.635	5.0	11	55	82	360	-35	+10	+10	43XW605F360K0AE
		.875	1.635	5.0	11	55	82	360	-35	+10	+10	43XW605F360K0AF
12	360	.875	2.420	10	18	90	135	180	-35	+10	+10	43XW126K360K0AE
		875	2.420	10	18	90	135	180	-35	+10	+10	43XW126K360K0AF
22	360	1.125	1.705	16	18	125	170	100	-40	+20	+25	43XW226T360K0AE
		1.125	1.705	16	18	125	170	100	-40	+20	+25	43XW226T360K0AA
30	360	1.125	1.705	22	19	135	182	120	-40	+20	+25	43XW306T360K0AE
		1.125	1.705	22	19	135	182	120	-40	+20	+25	43XW306T360K0AA
5	450	.875	2.000	4.9	11	55	82	450	-35	+10	+10	43XW505H450K0AE
		875	2 000	4 9	11	55	82	450	-35	+10	+10	43XW505H450K0AF
10	450	875	2 980	9 8	18	90	135	225	-35	+10	+10	43XW106M450K0AE
		875	2 980	9 8	18	90	135	225	-35	+10	+10	43XW106M450K0AF
17	450	1 125	2 080	16	18	125	170	130	-40	+20	+25	43XW176V450K0AE
		1 125	2 080	16	18	125	170	130	-40	+20	+25	43XW176V450K0AA
25	450	1 125	2 080	23	19	135	182	150	-40	+20	+25	43XW256V450K0AE
		1 125	2 080	23	19	135	182	150	-40	+20	+25	43XW256V450K0AA

3

Tantalum Capacitors

SERIES 43XW

Industrial Type Tantalum Capacitors

Cap (uF)	Volt	Size D +.031 −.015	Size H±.062	Max DF-120 Hz @ 25°C %	DC Leakage Current (Max) Microamperes 25°C	85°C	125°C	Impedance Ohms (Max) 120Hz -55°C	Maximum Capacitance Change Percent — Referenced to as 25 C -55°C	85°C	125°C	Part Number
4	540	.875	2.365	5 1	11	55	82	540	-35	+10	+10	43XW405J540K0AE
		.875	2.365	5 1	11	55	82	540	-35	+10	+10	43XW405J540K0AF
8	540	875	3.532	10	18	90	135	270	-35	+10	+10	43XW805N540K0AE
		875	3.532	10	18	90	135	270	-35	+10	+10	43XW805N540K0AF
14	540	1.125	2.435	16	17	120	162	160	-40	+20	+25	43XW146W540K0AE
		1.125	2.435	16	17	120	162	160	-40	+20	+25	43XW146W540K0AA
20	540	1.125	2 435	22	19	135	182	170	-40	+20	+25	43XW206W540K0AE
		1.125	2 435	22	19	135	182	170	-40	+20	+25	43XW206W540K0AA
3 5	630	875	2 720	5 0	11	55	82	630	-35	+10	+10	43XW355L630K0AE
		.875	2 720	5 0	11	55	82	630	-35	+10	+10	43XW355L630K0AF
7	630	.875	4 062	10	18	90	135	315	-35	+10	+10	43XW705O630K0AE
		875	4 062	10	18	90	135	315	-35	+10	+10	43XW705O630K0AF
12	630	1.125	2.810	16	17	120	162	180	-40	+20	+25	43XW126X630K0AE
		1 125	2.810	16	17	120	162	180	-40	+20	+25	43XW126X630K0AA
18	630	1.125	2.810	23	19	135	182	200	-40	+20	+25	43XW186X630K0AE
		1.125	2.810	23	19	135	182	200	-40	+20	+25	43XW186X630K0AA

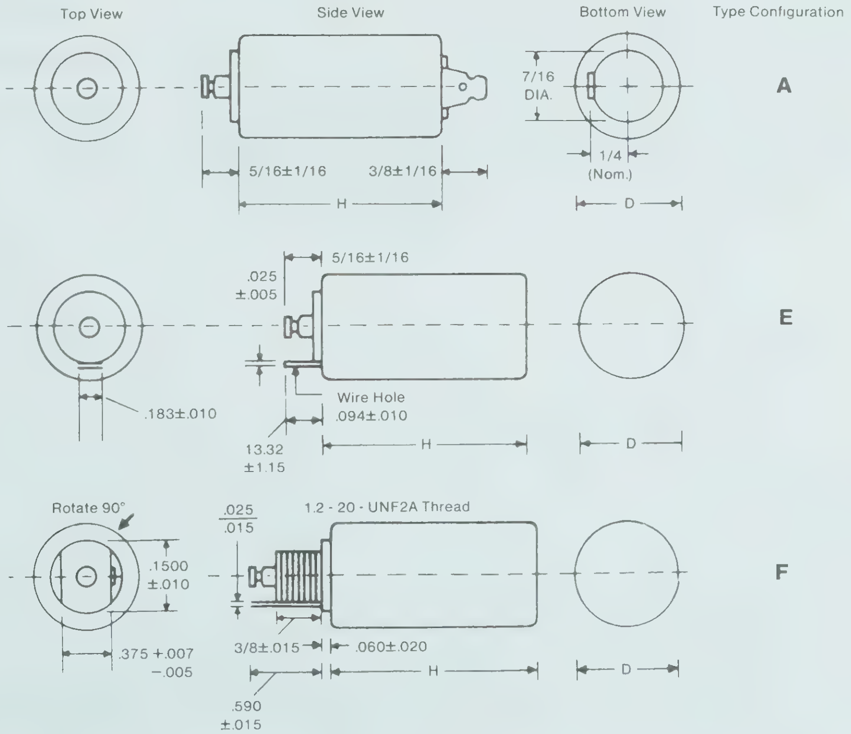
**Other Ratings Readily Available*

PART NUMBER SYSTEM

4 3 X W 107 A 020 K 0 A E

- E — CONFIGURATION
  - A = CL18
  - E = CL14, CL17
  - F = CL16
- A — INDUSTRIAL
- 0 — 0 = UNSLEEVED
  - 1 = SLEEVED
- K — CAPACITANCE TOLERANCE
  - K = ±10% M = ±20% U = +75 -15%
- 020 — VOLTAGE RATING @ 85 C
- A — CASE SIZE
- 107 — CAPACITANCE IN PICOFARADS
  - First two digits are significant figures
  - Third digit number of zeros to follow:
  - 106 = 10 uF
  - 107 = 100 uF
- W — WET ELECTROLYTE
- X — SERIES
- 3 — MODULE
- 4 — TANTALUM

TYPE AND CONFIGURATION

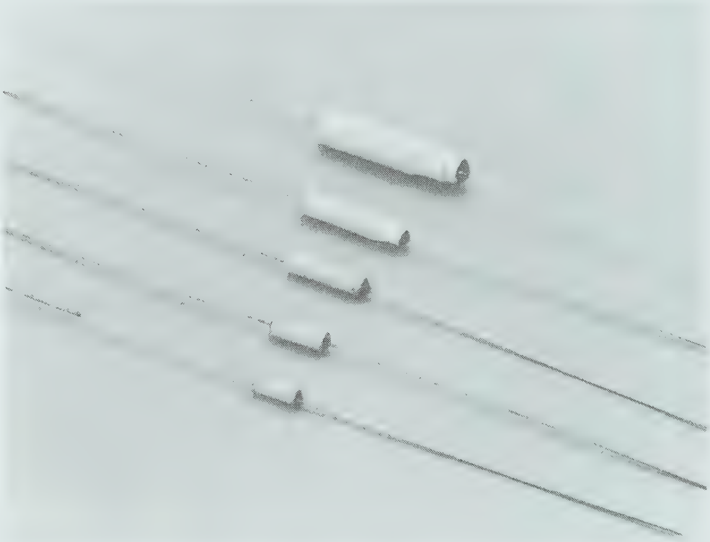


3

Tantalum Capacitors

SERIES 40YW

Non-Acid Electrolyte Fully Insulated Tantalum Capacitor



DESCRIPTION

Philips Components 40YW liquid electrolyte miniature Tantalum electrolytic capacitors fill d-c capacitor requirements where large capacitance values are required in very small spaces. These wet-electrolyte capacitors are suitable for storage at temperatures to −65°C, and will meet military vibration requirements at 2000 Hz, 15 G acceleration and all normal shock requirements.

FEATURES

- 6 TO 60 VOLTS
- −55°C TO +85°C
- 0.1 uF TO 320 uF
- SOLDER COATED NICKEL LEADS

WARNING
NON-SOLID ELECTROLYTIC CAPACITORS MAY CONTAIN CHEMICALS WHICH CAN BE REGARDED AS HAZARDOUS IF HANDLED INCORRECTLY. CAUTION IS NECESSARY IF THE OUTER CASE IS FRACTURED.

SERIES 40YW

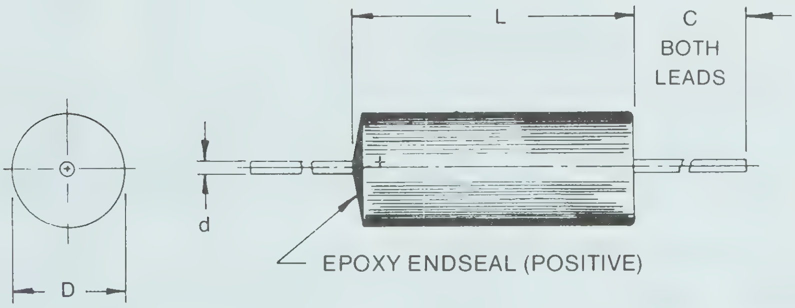
Industrial Type Tantalum Capacitors

PART NUMBER SYSTEM

EXAMPLE

4 0 Y W 205 B 060 U 1 A

- A — INDUSTRIAL
- 1 — SLEEVED
- U — CAPACITANCE TOLERANCE
  - U = -15 +75% (6-25V)
  - T = -15 +50% (30-60V)
  - W = 15 + 20% (ALL)
- 060 — VOLTAGE RATING @ 85°C
- B — CASE SIZE
- 205 — CAPACITANCE IN PICOFARADS
  First two digits are significant figures.
  Third digit number of zeros to follow:
  - 205 = 2 uF
  - 206 = 20 uF
- W — WET ELECTROLYTE
- Y — SERIES
- 0 — AXIAL LEAD
- 4 — TANTALUM CAPACITOR



DIMENSIONS FOR 40YW TYPE — INCHES (mm)

Case Size	D max	L max	Lead dia. d	Lead length C ±.375	Weight (grams)
A	.080 (2.0)	.285 (7.2)	.020 (0.5)	2.0 (50.8)	.26
B	.115 (2.9)	.312 (7.9)	.020 (0.5)	2.0 (50.8)	.36
C	.115 (2.9)	.438 (11.1)	.020 (0.5)	2.0 (50.8)	.50
D	.145 (3.7)	.656 (16.7)	.020 (0.5)	2.0 (50.8)	1.00
E	.225 (5.7)	.875 (22.2)	.020 (0.5)	2.0 (50.8)	2.76

SERIES 40YW
Industrial Type Tantalum Capacitors

Case Size	Cap (uF)	WVDC at 85°C	Surge Voltage at 85°C	Max Impedance 120 Hz (Ohms)			Max DC Leakage Current (ua)		Max DF-120 Hz %	Typical ESR at 25°C (Ohms)	Part Number Standard
				+55°C	25°C	85°C	25°C	85°C	25°C		
B	15	6	7	500	110	110	1	3	30	14	40YW156B006U1A
C	30	6	7	300	56	54	1	6	44	8	40YW306C006U1A
D	140	6	7	150	12	12	1.5	7.5	52	5	40YW147D006U1A
E	320	6	7	100	6	5.6	2	10	82	3	40YW327E006U1A
C	25	8	9	350	68	66	1	6	32	8	40YW256C008U1A
B	10	10	12	600	165	160	1	3	28	14	40YW106B010U1A
D	100	10	12	160	17	16	1.5	7.5	46	5	40YW107D010U1A
E	250	10	12	110	7	6.5	2	10	44	3	40YW257E010U1A
B	8	15	18	700	200	200	1	3	24	14	40YW805B015U1A
C	20	15	18	400	80	80	1	6	24	8	40YW206C015U1A
D	70	15	18	170	23	23	1.5	7.5	36	5	40YW706D015U1A
E	170	15	18	120	9.6	9.4	2	10	44	3	40YW177E015U1A
C	15	20	23	450	110	110	1	6	23	8	40YW156C020U1A
D	50	20	23	180	33	32	1.5	7.5	30	5	40YW506D020U1A
B	6	25	29	900	270	270	1	3	18	14	40YW605B025U1A
C	10	25	29	500	160	160	1	6	18	8	40YW106C025U1A
B	5	30	35	1,000	320	320	1	3	18	14	40YW505B030T1A
C	8	30	35	550	200	200	1	6	12	8	40YW805C030T1A
D	40	30	35	190	41	40	1.5	7.5	30	5	40YW406D030T1A
E	100	30	35	140	17	16.5	2	10	44	3	40YW107D030T1A
A	0.1	50	58	16,000	15,000	15,000	1	2	6	150	40YW104A050T1A
A	0.5	50	58	4,000	3,500	3,500	1	2	6	30	40YW504A050T1A
A	1.0	50	58	2,500	2,000	2,000	1	2	6	16	40YW105A050T1A
B	3	50	58	1,200	540	540	1	3	12	14	40YW305B050T1A
C	6	50	58	600	275	275	1	6	44	8	40YW605C050T1A
D	25	50	58	200	65	65	1.5	7.5	24	5	40YW256D050T1A
E	60	50	58	180	27	26.5	2	10	24	3	40YW606E050T1A
B	2	60	70	1,250	800	800	1	3	12	14	40YW205B060T1A
C	4	60	70	750	400	400	1	6	12	8	40YW405C060T1A
D	20	60	70	200	82	80	1.5	7.5	24	5	40YW206D060T1A
E	50	60	70	200	32	32	2	10	18	3	40YW506E060T1A

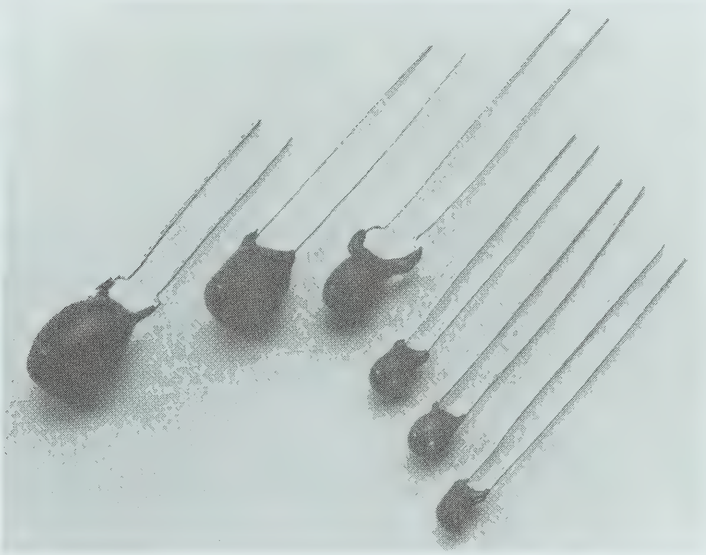
CAPACITANCE TOLERANCE

Condition	Voltage Rating	Percent Tolerance Standard
25°C @ 120 Hz	6 to 25	-15+75
	30 to 60	-15+50

3

Tantalum Capacitors

Econodip Commercial Grade Dipped-Radial Lead Solid Electrolyte Tantalum Capacitor



DESCRIPTION

The 41GS type capacitors are designed and manufactured for low unit cost in volume production quantities and reliable operation in a wide variety of commercial and consumer circuit applications.

The inherent reliability of the solid tantalum capacitor is offered in a radial lead capacitor which incorporates an insulating protective body coating to withstand production handling in automated processing or assembly equipment.

The 41GS Series provides a wide variety of standard capacitance-voltage ratings to accommodate the use of the dipped capacitor series for replacement of axial lead capacitor styles on printed circuit boards.

The six case sizes are supplied with standard lead spacing of 0.100″ (2.54 mm), 0.125″ (3.18 mm), 0.200″ (5.08 mm).

Four of the case sizes are available with hockey-stick leads with 0.250″ (6.35 mm) lead spacing.

FEATURES

- −55°C to +85°C TEMPERATURE RANGE
- 0.1 uf THROUGH 680.0 uf
- 3 VDC THROUGH 50 VDC
- SIX STANDARD CASE SIZES
- STRAIGHT AND FORMED LEADS AVAILABLE
- STABLE ELECTRICAL CHARACTERISTICS
- RESIN COATED
- LOW COST
- LOW D.C. LEAKAGE
- STANDARD .020″ DIAMETER LEAD WIRES

SERIES 41GS
Industrial Type Tantalum Capacitors

3

Tantalum Capacitors

CAPACITANCE — Measured at 25 C at 120 Hz using the bridge method with 1 VRMS and 2.2 VDC maximum applied to the device See table for standard capacitance-voltage ratings

CAPACITANCE TOLERANCE — ±20% (M) is standard. ±10% (K) is available upon request

DISSIPATION FACTOR — Determined by the same method as capacitance. DF in percent shall not exceed the following:

Rated Capacitance	Maximum DF
0.1 uf to 6.8 uf	6%
8.2 uf to 68 uf	8%
82 uf to 330 uf	10%
470 uf to 680 uf	12%

D.C. LEAKAGE - Shall not exceed .02 X CV (capacitance X voltage) or 1 ua whichever is greater at 25°C when measured with rated voltage applied. The electrification period, prior to measurement, shall be 5 minutes. A regulated power supply with an external 1000 ohm resistor in series with each unit should be used to supply the D.C. test and electrification voltage. 85 C.D.C. leakage shall not exceed 10 X CV or 10 ua, whichever is greater, when measured as described above.

WVDC WORKING VOLTS D.C.
RVDC RATED VOLTAGE D.C. — The 41GS Series is designed to operate reliably in a wide variety of environments between -55 C and +85 C with rated voltage applied

SURGE VOLTAGE — The surge voltage is the maximum D.C voltage, including peak AC or other pulse voltages which may be applied to the capacitor for short periods of time

Rated D.C. Voltage	Maximum Surge Voltage
3	3.6
6.3	8
10	12
16	19
20	26
25	30
35	42
50	60

CIRCUIT RESISTANCE — Low impedance surges may do permanent damage to solid tantalum capacitors. Normal circuit applications should include a total resistance value equal to 3 ohms per applied volt.

CAPACITANCE CHANGE WITH TEMPERATURE —

Temperature	Capacitance Change (Maximum)
-55 C	-12% of initial measurement
+85 C	+12% of initial measurement

Reference measurement (initial) will be taken at +25 C.

REVERSE VOLTAGE — The maximum allowable reverse voltage at 25 C is 10% of the rated voltage or 0.8 volt, whichever is greater.

At 85 C the maximum allowable reverse voltage is 5% of the voltage rating or 0.4 volt, whichever is greater.

The 41GS is a polarized capacitor series and should not be subjected to reverse voltages for long time periods.

LEAD MATERIAL — Lead material is #24 AWG/.020" (.051 mm) diameter Grade A nickel, tin lead plated to facilitate soldering.

TERMINAL STRENGTH — Each lead will withstand a 2 lb. (907.2 gr) pull applied axially for a period of 10 seconds without lead or weld failure. Each lead will withstand two 90 bends, with no stress applied to the case, without failure.

The terminal strength test is considered a destructive test.

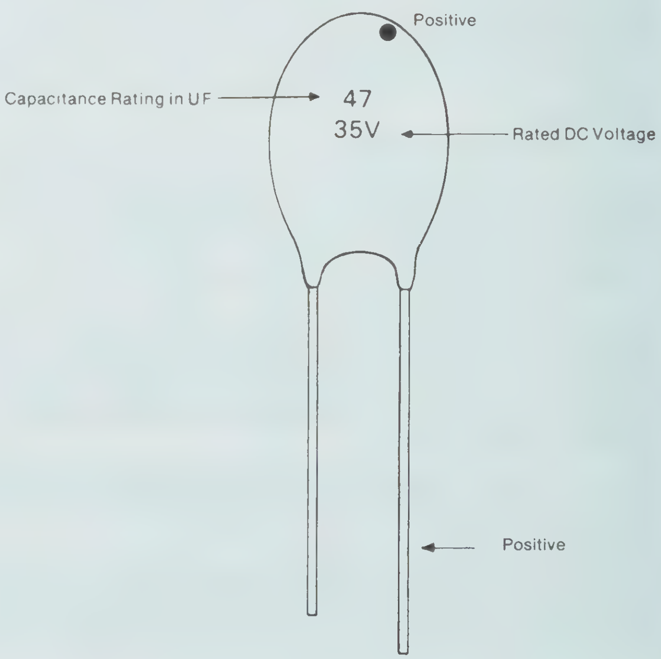
LIFE TEST — Capacitors shall withstand a 1000 hour life test at 85 C with rated voltage continuously applied. A minimum of circuit impedance in series with each unit will be 3 ohms per applied volt.

At the completion of the life test, the following electrical limits apply:

Characteristic	Post Life Test Requirements
Capacitance	±10% of initial value
Dissipaton Factor	150% of original requirments
D.C. Leakage	200% of initial requirement

MARKING — Each capacitor will be marked with the rated capacitance, a capacitance tolerance identifier letter and the rated voltage.

The positive lead is the longer of the two leads. A red dot will indicate positive lead wire.



SERIES 41GS

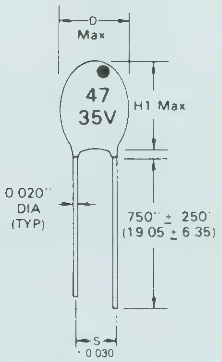
Industrial Type Tantalum Capacitors

PHILIPS COMPONENTS PART NUMBERING SYSTEM

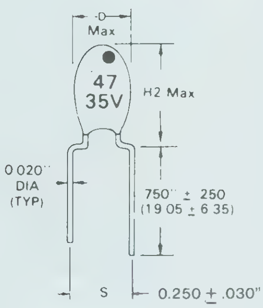
4 1 G S 154 A 050 K 0 A V

- 4 — TANTALUM CAPACITOR
- 1 — RADIAL LEAD
- G — SERIES
- S — SOLID ELECTROLYTE
- 154 — CAPACITANCE IN PICOFARADS. First two digits are significant figures. Third digit is number of zeros to follow: 154 = 15 uF, 155 = 1 5 uF
- A — CASE SIZE
- 050 — RATED VOLTAGE AT 85°C
- K — CAPACITANCE TOLERANCE J = ±5% K = ±10% M = ±20%
- 0 — UNSLEEVED
- A — INDUSTRIAL
- V — LLAD SPACING CODE V = .100 grid W = .125 grid X = .200 grid Y = .250 grid

Case Code	Terminal Codes Available	Diameter "D" Max. In. (mm)	Height "H1" Max. In. (mm)	Height "H2" Max. In (mm)
A	V. Y	0.180 (4.57)	0.280 (7.11)	.410 (10.41)
B	V. Y	0.200 (5.08)	0.300 (7.62)	.430 (10.92)
C	W. Y	0.260 (6.60)	0.360 (9.14)	.490 (12.45)
D	W. Y	0.340 (8.64)	0.400 (10.16)	.540 (13.72)
E	X & Y	0.400 (10.16)	0.560 (14.22)	.650 (16.50)
F	X & Y	0.440 (11.18)	0.680 (17.27)	.750 (19.05)



TERMINAL V



TERMINAL Y

Lead Wire Diameter .020"/#24 AWG On All Case Sizes

SERIES 41GS

Industrial Type Tantalum Capacitors

PHILIPS COMPONENTS STANDARD RATINGS

-55°C to +85°C — 41GS SERIES

Capacitance 120 Hz	A 3 WVDC 3.6 VDC Surge	B 6.3 WVDC 8 VDC Surge	D 10 WVDC 12 VDC Surge	E 16 WVDC 19 VDC Surge
.10	41GS104A003K0A	41GS104A006K0A	41GS104A010K0A	41GS104A016K0A
.15	41GS154A003K0A	41GS154A006K0A	41GS154A010K0A	41GS154A016K0A
.22	41GS224A003K0A	41GS224A006K0A	41GS224A010K0A	41GS224A016K0A
.33	41GS334A003K0A	41GS334A006K0A	41GS334A010K0A	41GS334A016K0A
.47	41GS474A003K0A	41GS474A006K0A	41GS474A010K0A	41GS474A016K0A
.68	41GS684A003K0A	41GS684A006K0A	41GS684A010K0A	41GS684A016K0A
1.0	41GS105A003K0A	41GS105A006K0A	41GS105A010K0A	41GS105A016K0A
1.5	41GS155A003K0A	41GS155A006K0A	41GS155A010K0A	41GS155A016K0A
2.2	41GS225A003K0A	41GS225A006K0A	41GS225A010K0A	41GS225A016K0A
3.3	41GS335A003K0A	41GS335A006K0A	41GS335A010K0A	41GS335B016K0A
4.7	41GS475A003K0A	41GS475A006K0A	41GS475B010K0A	41GS475B016K0A
6.8	41GS685A003K0A	41GS685B006K0A	41GS685B010K0A	41GS685B016K0A
10	41GS106B003K0A	41GS106B006K0A	41GS106B010K0A	41GS106C016K0A
15	41GS156B003K0A	41GS156B006K0A	41GS156C010K0A	41GS156C016K0A
22	41GS226B003K0A	41GS226C006K0A	41GS226C010K0A	41GS226D016K0A
33	41GS336C003K0A	41GS336C006K0A	41GS336D010K0A	41GS336D016K0A
47	41GS476C003K0A	41GS476D006K0A	41GS476D010K0A	41GS476E016K0A
68	41GS686D003K0A	41GS686D006K0A	41GS686D010K0A	41GS686E016K0A
100	41GS107D003K0A	41GS107D006K0A	41GS107E010K0A	41GS107F016K0A
150	41GS157D003K0A	41GS157E006K0A	41GS157E010K0A	41GS157F016K0A
220	41GS227E003K0A	41GS227E006K0A	41GS227F010K0A	
330	41GS337E003K0A	41GS337F006K0A		
470	41GS477F003K0A			
680	41GS687F003K0A			

Capacitance 120 Hz	F 20 WVDC 26 VDC Surge	G 25 WVDC 30 VDC Surge	H 35 WVDC 42 VDC Surge	J 50 WVDC 60 VDC Surge
.10	41GS104A020K0A	41GS104A025K0A	41GS104A035K0A	41GS104A050K0A
.15	41GS154A020K0A	41GS154A025K0A	41GS154A035K0A	41GS154A050K0A
.22	41GS224A020K0A	41GS224A025K0A	41GS224A035K0A	41GS224A050K0A
.33	41GS334A020K0A	41GS334A025K0A	41GS334A035K0A	41GS334A050K0A
.47	41GS474A020K0A	41GS474A025K0A	41GS474A035K0A	41GS474B050K0A
.68	41GS684A020K0A	41GS684A025K0A	41GS684A035K0A	41GS684B050K0A
1.0	41GS105A020K0A	41GS105A025K0A	41GS105B035K0A	41GS105C050K0A
1.5	41GS155A020K0A	41GS155A025K0A	41GS155B035K0A	41GS155C050K0A
2.2	41GS225B020K0A	41GS225B025K0A	41GS225C035K0A	41GS225D050K0A
3.3	41GS335B020K0A	41GS335B025K0A	41GS335C035K0A	41GS335D050K0A
4.7	41GS475C020K0A	41GS475C025K0A	41GS475D035K0A	41GS475D050K0A
6.8	41GS685C020K0A	41GS685C025K0A	41GS685D035K0A	41GS685F050K0A
10	41GS106C020K0A	41GS106C025K0A	41GS106D035K0A	41GS106F050K0A
15	41GS156D020K0A	41GS156D025K0A	41GS156E035K0A	
22	41GS226D020K0A	41GS226D025K0A	41GS226E035K0A	
33	41GS336E020K0A	41GS336E025K0A	41GS336F035K0A	
47	41GS476E020K0A	41GS476E025K0A	41GS476F035K0A	
68	41GS686F020K0A	41GS686F025K0A		

3 Tantalum Capacitors

SERIES 40MS

Extended Range Molded Solid-Tantalum Industrial Grade Capacitor

3

Tantalum Capacitors

DESCRIPTION

The Philips Components "40MS" type molded solid-tantalum capacitor series offers all of the advantages of solid-tantalum capacitors while providing the cost savings associated with non-metal case technology.

The fabrication of the tantalum anode is performed on the same presses and chemical processing is accomplished using the same equipment that is utilized in the fabrication of established reliability, military style capacitors.

Over 300 standard capacitance-voltage ratings, encased in four precision molded case sizes, provide just the right capacitor to meet most circuit requirements for electrical performance and physical size.

The "40MS" product is intended for large quantity usage to optimize cost savings associated with molded case products.

This industrial grade product is widely used in industrial, automotive and commercial products, and in circuit applications which include filtering, time constant, coupling, by-passing and energy storage applications.

The positive lead is indicated by the chamfered case end, which provides easy visual identification of the positive lead of this polarized capacitor style.

The "40MS" product is supplied lead taped and reeled for use in high speed automatic insertion equipment.

FEATURES

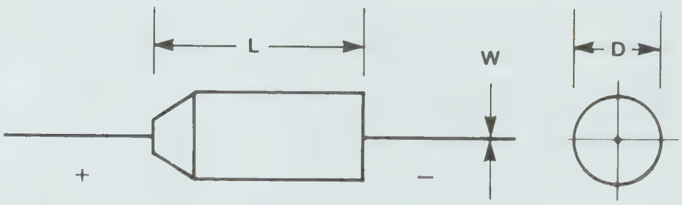
- Molded, Insulated Case Construction
- −55°C Through +125°C Operation
- 4 Standard "Chamfered End" Case Sizes
- Capacitance Range: 0.1 μF Through 68.0 μF
- Voltage Range: 2 VDC Through 50 VDC
- Tape and Reel Packaging
- Weldable And Solderable Leads

SERIES 40MS

Industrial Type Tantalum Capacitors

PHYSICAL SPECIFICATIONS

OUTLINE DRAWING AND DIMENSIONS



W = WIRE DIA.

Case Size	Dimensions — Inches (mm)		
	D Max.	L Max.	W Max.
A	0.095 (2.41)	0.260 (6.60)	0.020 (.51)
B	0.110 (2.79)	0.290 (7.37)	0.020 (.51)
C	0.180 (4.57)	0.345 (8.76)	0.020 (.51)
D	0.180 (4.57)	0.420 (10.67)	0.020 (.51)

Lead Length = 1.50 ± .125 inch (38.1 ± 3.18)

Maximum Capacitance (μF) by Case Size and Voltage

Volts	A	B	C	D
2	10.0	33.0	68.0	—
4	6.8	22.0	47.0	68.0
6	4.7	15.0	33.0	56.0
10	3.3	10.0	22.0	47.0
15	2.2	6.8	15.0	33.0
20	1.5	4.7	10.0	22.0
25	1.0	3.3	10.0	15.0
35	0.47	1.5	4.7	10.0
50	0.27	1.0	2.2	4.7

Marking

Capacitors will be marked with Philips Components part marking capacitance, tolerance, rated DC voltage, a + sign for polarity and EIA date code. Capacitance tolerance will be expressed as K=10%, M=20% or J=5%.

ELECTRICAL DATA

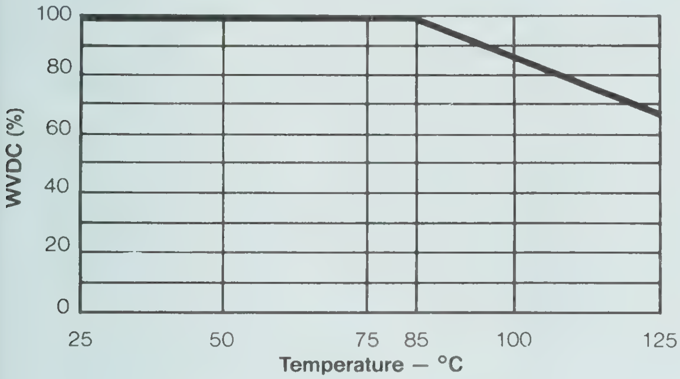
DC Working Voltage

Philips Components 40MS solid-tantalum capacitors are available in nine standard operating voltages, as shown in the capacitance-voltage table.

All 40MS type capacitors may be operated at their rated voltage throughout the temperature range of −55°C through +85°C.

These capacitors may be operated at 2/3 of the rated voltage up to a maximum temperature of +125°C.

AC ripple voltage plus the DC polarizing voltage must not exceed the rated WVDC voltage.



(NOTE — See Table Following)

Surge Voltage and Voltage Derating

The surge voltage is the maximum short duration voltage which may be applied to the capacitor, i.e., "Turn On" transients, peak AC voltages or any other voltage pulses which may be superimposed on the applied DC voltage.

85°C and 125°C surge voltages and voltage derating with temperature for 40MS capacitors are shown in the following table.

Working Voltage WVDC 85°C	Derated VDC 125°C	Surge VDC	
		85°C	125°C
2	1.3	2.6	1.6
4	3.0	5.0	4.0
6	4.0	8.0	5.0
10	7.0	13.0	9.0
15	10.0	20.0	12.0
20	13.0	26.0	16.0
25	16.5	31.0	20.0
35	23.0	46.0	28.0
50	33.0	65.0	40.0

Capacitance...(Effective Series Capacitance)

Philips Components 40MS molded solid-tantalum capacitors are measured on a polarized capacitance bridge. All measurements are made at, and referred to, a 120 HZ frequency at 25°C measurement condition.

The AC measuring signal shall be limited to 2 VAC peak.

The sum of the peak AC voltage and the applied (polarizing) DC voltage shall not exceed the rated (WVDC) voltage of the capacitor.

Capacitance Tolerance

The 40MS series is available in ±20%(M), ±10%(K) or ±5%(J) capacitance tolerances.

Dissipation Factor

The dissipation factor at 120 HZ and 25°C will be measured concurrently with capacitance. Maximum dissipation factor (DF) limits are specified in the capacitance voltage rating table by individual unit.

Rated Voltage (WVDC)	Maximum Dissipation Factor Range (%)
2	10
4	8
6	6
Greater Than 6	6

DC Leakage Current

DC leakage measurements will be taken after a five minute period of electrification, with rated DC voltage applied.

The voltage will be applied with a 1000 Ohm, ±50 Ohm, resistor connected in series with the capacitor.

The DC leakage limit values for individual units are shown in the Capacitance-Voltage Rating Table.

The maximum allowable DC leakage limit at 85°C will be 10 times the maximum specified 25°C DC leakage limit.

Capacitance Change with Temperature

The maximum capacitance change with temperature is:

Temperature °C	Maximum Change In Capacitance (%)
25	Within Specified Tolerance
−55	15
85	15

Moisture Resistance

The 40MS series capacitors will meet the moisture resistance requirements of MIL-STD 202D, method 106.

Within 6 hours of the completion of the test, the capacitance will not change more than ±5% from the initial value. The dissipation factor will not exceed the initial requirement.

SERIES 40MS

Industrial Type Tantalum Capacitors

CAPACITANCE VOLTAGE RATING TABLE

μF	VDC	Case Size	120 HZ DF (%)	25°C DCL (μA)	Philips Components Part Number
6.8	2	A	10	0.5	40MS685A002K0A
8.2	2	A	10	0.5	40MS825A002K0A
10.0	2	A	10	0.5	40MS106A002K0A
12.0	2	B	10	0.5	40MS126B002K0A
15.0	2	B	10	0.5	40MS156B002K0A
18.0	2	B	10	0.5	40MS186B002K0A
22.0	2	B	10	0.5	40MS226B002K0A
27.0	2	B	10	0.5	40MS276B002K0A
33.0	2	B	10	0.7	40MS336B002K0A
39.0	2	C	10	0.7	40MS396C002K0A
47.0	2	C	10	1.0	40MS476C002K0A
56.0	2	C	10	1.0	40MS566C002K0A
68.0	2	C	10	1.4	40MS686C002K0A
4.7	4	A	8	0.5	40MS475A004K0A
5.6	4	A	8	0.5	40MS565A004K0A
6.8	4	A	8	0.5	40MS685A004K0A
8.2	4	B	8	0.5	40MS825B004K0A
10.0	4	B	8	0.5	40MS106B004K0A
12.0	4	B	8	0.5	40MS126B004K0A
15.0	4	B	8	0.6	40MS156B004K0A
18.0	4	B	8	0.6	40MS186B004K0A
22.0	4	B	8	0.9	40MS226B004K0A
27.0	4	C	8	0.9	40MS276C004K0A
33.0	4	C	8	1.4	40MS336C004K0A
39.0	4	C	8	1.4	40MS396C004K0A
47.0	4	C	8	1.9	40MS476C004K0A
56.0	4	D	8	1.9	40MS566D004K0A
68.0	4	D	8	2.8	40MS686D004K0A
3.3	6	A	4	0.5	40MS335A006K0A
3.9	6	A	4	0.5	40MS395A006K0A
4.7	6	A	4	0.5	40MS475A006K0A
5.6	6	B	4	0.5	40MS565B006K0A
6.8	6	B	6	0.5	40MS685B006K0A
8.2	6	B	6	0.5	40MS825B006K0A
10.0	6	B	6	0.6	40MS106B006K0A
12.0	6	B	6	0.6	40MS126B006K0A
15.0	6	B	6	0.9	40MS156B006K0A
18.0	6	C	6	0.9	40MS186C006K0A
22.0	6	C	6	1.4	40MS226C006K0A
27.0	6	C	6	1.4	40MS276C006K0A
33.0	6	C	6	1.5	40MS336C006K0A
39.0	6	D	6	2.0	40MS396D006K0A
47.0	6	D	6	2.8	40MS476D006K0A
56.0	6	D	6	2.8	40MS566D006K0A
68.0	6	D	6	4.1	40MS686D006K0A
2.2	10	A	4	0.5	40MS225A010K0A
2.7	10	A	4	0.5	40MS275A010K0A
3.3	10	A	4	0.5	40MS335A010K0A
3.9	10	B	4	0.5	40MS395B010K0A

μF	VDC	Case Size	120 HZ DF (%)	25°C DCL (μA)	Philips Components Part Number
4.7	10	B	4	0.5	40MS475B010K0A
5.6	10	B	4	0.5	40MS565B010K0A
6.8	10	B	6	0.7	40MS685B010K0A
8.2	10	B	6	0.7	40MS825B010K0A
10.0	10	B	6	1.0	40MS106B010K0A
12.0	10	C	6	1.0	40MS126C010K0A
15.0	10	C	6	1.5	40MS156C010K0A
18.0	10	C	6	1.5	40MS186C010K0A
22.0	10	C	6	1.5	40MS226C010K0A
27.0	10	D	6	2.2	40MS276D010K0A
33.0	10	D	6	3.0	40MS336D010K0A
39.0	10	D	6	3.3	40MS396D010K0A
47.0	10	D	6	4.7	40MS476D010K0A
1.5	15	A	4	0.5	40MS155A015K0A
1.8	15	A	4	0.5	40MS185A015K0A
2.2	15	A	4	0.5	40MS225A015K0A
2.7	15	B	4	0.5	40MS275B015K0A
3.3	15	B	4	0.5	40MS335B015K0A
3.9	15	B	4	0.5	40MS395B015K0A
4.7	15	B	4	0.7	40MS475B015K0A
5.6	15	B	4	0.7	40MS565B015K0A
6.8	15	B	6	1.0	40MS685B015K0A
8.2	15	C	6	1.1	40MS825C015K0A
10.0	15	C	6	1.5	40MS106C015K0A
12.0	15	C	6	1.5	40MS126C015K0A
15.0	15	C	6	1.5	40MS156C015K0A
18.0	15	D	6	2.3	40MS186D015K0A
22.0	15	D	6	3.0	40MS226D015K0A
27.0	15	D	6	3.3	40MS276D015K0A
33.0	15	D	6	5.0	40MS336D015K0A
1.0	20	A	4	0.5	40MS105A020K0A
1.2	20	A	4	0.5	40MS125A020K0A
1.5	20	A	4	0.5	40MS155A020K0A
1.8	20	B	4	0.5	40MS185B020K0A
2.2	20	B	4	0.5	40MS225B020K0A
2.7	20	B	4	0.5	40MS275B020K0A
3.3	20	B	4	0.7	40MS335B020K0A
3.9	20	B	4	0.7	40MS395B020K0A
4.7	20	B	4	1.0	40MS475B020K0A
5.6	20	C	4	1.0	40MS565C020K0A
6.8	20	C	6	1.4	40MS685C020K0A
8.2	20	C	6	1.4	40MS825C020K0A
10.0	20	C	6	2.0	40MS106C020K0A
12.0	20	D	6	2.0	40MS126D020K0A
15.0	20	D	6	3.0	40MS156D020K0A
18.0	20	D	6	3.0	40MS186D020K0A
22.0	20	D	6	4.4	40MS226D020K0A
0.47	25	A	3	0.5	40MS474A025K0A

*Insert Capacitance Tolerance Letter in Part Number: M = ±20%   K = ±10%

SERIES 40MS

Industrial Type Tantalum Capacitors

CAPACITANCE VOLTAGE RATING TABLE

μF	VDC	Case Size	120 HZ DF (%)	25°C DCL (μA)	Philips Components Part Number
0.56	25	A	3	0.5	40MS564A025K0A
0.68	25	A	3	0.5	40MS684A025K0A
0.82	25	A	3	0.5	40MS824A025K0A
1.0	25	A	3	0.5	40MS105A025K0A
1.2	25	B	3	0.5	40MS125B025K0A
1.5	25	B	3	0.5	40MS155B025K0A
1.8	25	B	3	0.5	40MS185B025K0A
2.2	25	B	3	0.6	40MS225B025K0A
2.7	25	B	3	0.6	40MS275B025K0A
3.3	25	B	3	0.9	40MS335B025K0A
3.9	25	C	3	0.9	40MS395C025K0A
4.7	25	C	4	1.2	40MS475C025K0A
5.6	25	C	4	1.2	40MS565C025K0A
6.8	25	C	4	1.5	40MS685C025K0A
8.2	25	C	4	1.5	40MS825C025K0A
10.0	25	C	4	1.5	40MS106C025K0A
12.0	25	D	4	2.5	40MS126D025K0A
15.0	25	D	4	3.8	40MS156D025K0A
0.10	35	A	3	0.5	40MS104A035K0A
0.12	35	A	3	0.5	40MS124A035K0A
0.15	35	A	3	0.5	40MS154A035K0A
0.18	35	A	3	0.5	40MS184A035K0A
0.22	35	A	3	0.5	40MS224A035K0A
0.27	35	A	3	0.5	40MS274A035K0A
0.33	35	A	3	0.5	40MS334A035K0A
0.39	35	A	3	0.5	40MS394A035K0A
0.47	35	A	3	0.5	40MS474A035K0A
0.56	35	B	3	0.5	40MS564B035K0A
0.68	35	B	3	0.5	40MS684B035K0A
0.82	35	B	3	0.5	40MS824B035K0A
1.0	35	B	3	0.5	40MS105B035K0A
1.2	35	B	3	0.5	40MS125B035K0A
1.5	35	B	3	0.6	40MS155B035K0A
1.8	35	C	3	0.6	40MS185C035K0A
2.2	35	C	3	0.8	40MS225C035K0A
2.7	35	C	3	0.8	40MS275C035K0A
3.3	35	C	4	1.2	40MS335C035K0A
3.9	35	C	4	1.2	40MS395C035K0A
4.7	35	C	4	1.5	40MS475C035K0A
5.6	35	D	4	1.7	40MS565D035K0A
6.8	35	D	4	2.4	40MS685D035K0A
8.2	35	D	4	2.4	40MS825D035K0A
10.0	35	D	4	3.5	40MS106D035K0A
0.1	50	A	3	0.5	40MS104A050K0A
0.12	50	A	3	0.5	40MS124A050K0A
0.15	50	A	3	0.5	40MS154A050K0A
0.18	50	A	3	0.5	40MS184A050K0A
0.22	50	A	3	0.5	40MS224A050K0A
0.27	50	A	3	0.5	40MS274A050K0A
0.33	50	B	3	0.5	40MS334B050K0A

μF	VDC	Case Size	120 HZ DF (%)	25°C DCL (μA)	Philips Components Part Number
0.39	50	B	3	0.5	40MS394B050K0A
0.47	50	B	3	0.5	40MS474B050K0A
0.56	50	B	3	0.5	40MS564B050K0A
0.68	50	B	3	0.5	40MS684B050K0A
0.82	50	B	3	0.5	40MS824B050K0A
1.0	50	B	3	0.5	40MS105B050K0A
1.2	50	C	3	0.5	40MS125C050K0A
1.5	50	C	4	0.8	40MS155C050K0A
1.8	50	C	4	0.8	40MS185C050K0A
2.2	50	C	4	1.1	40MS225C050K0A
2.7	50	D	4	1.1	40MS275D050K0A
3.3	50	D	4	1.7	40MS335D050K0A
3.9	50	D	4	1.7	40MS395D050K0A
4.7	50	D	4	2.4	40MS475D050K0A

HOW TO SPECIFY

4 0 M S 685 D 035 M 0 A

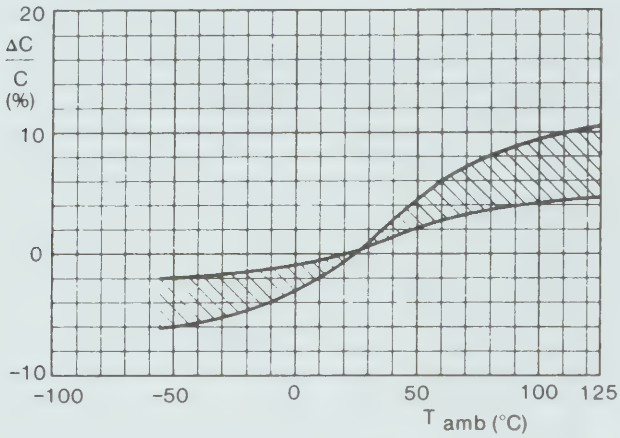
- A — Industrial
- 0 — UNSLEEVED
- M — **Capacitance Tolerance** M = 20% K = 10% J – 5%
- 035 — **Voltage Rating**
- D — **Case Size**
- 685 — **Capacitance in Picofarads** First two digits are significant figures. Third digit number of zeros to follow: 685 = 6.8 μF, 686 = 68 μF
- S — **Solid-Tantalum**
- M — **Molded Case**
- 0 — **Axial Lead**
- 4 — **Tantalum Capacitor**

*Insert Capacitance Tolerance Letter in Part Number: M = ±20% K = ±10%

SERIES 40MS

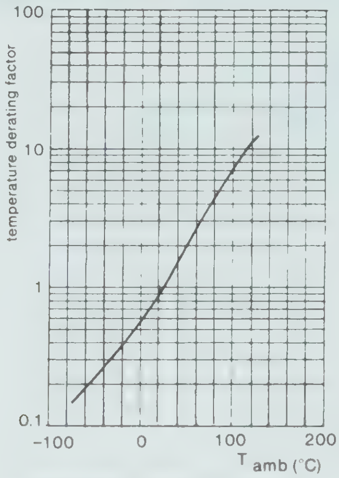
Industrial Type Tantalum Capacitors

Capacitance Change with Temperature

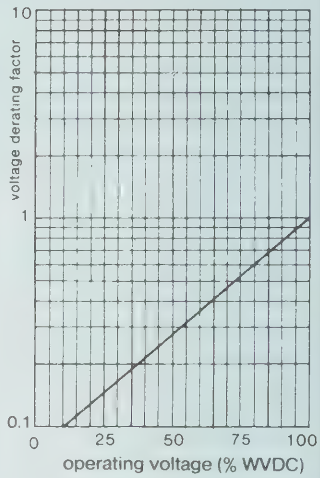


Typical capacitance as a function of ambient temperature.

Leakage Current



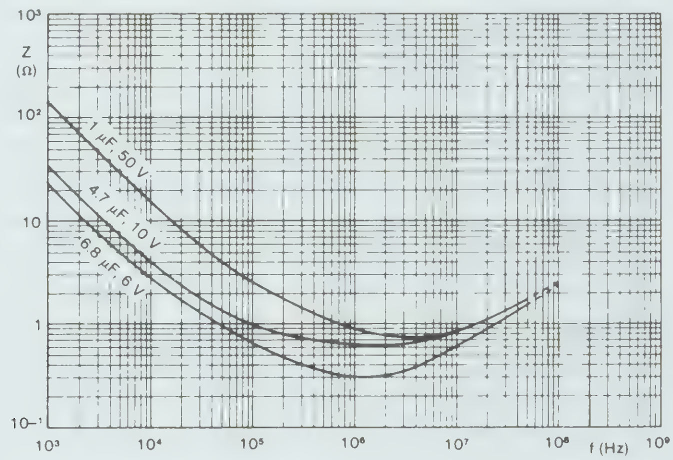
Typical effect of ambient temperature on leakage current.



Typical effect of operating voltage on leakage current

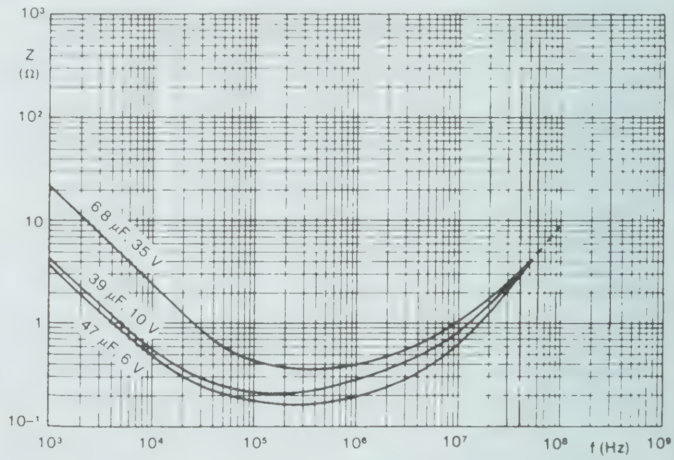
Impedance

The impedance is measured by means of a four-terminal circuit (Thomson circuit)



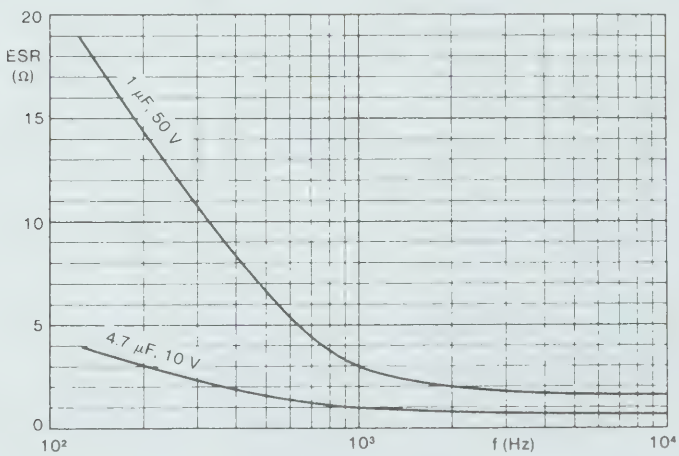
Typical impedance as a function of frequency at 25°C; case sizes B and E.

Impedance



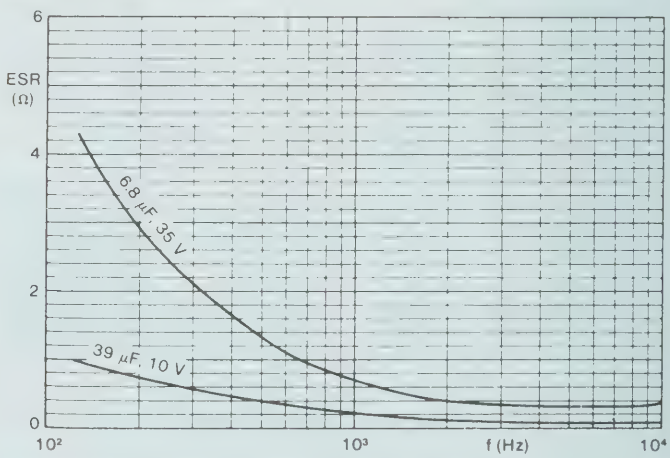
Typical impedance as a function of frequency at 25°C; case sizes D and F.

Equivalent Series Resistance



Typical ESR as a function of frequency; case sizes B and E.

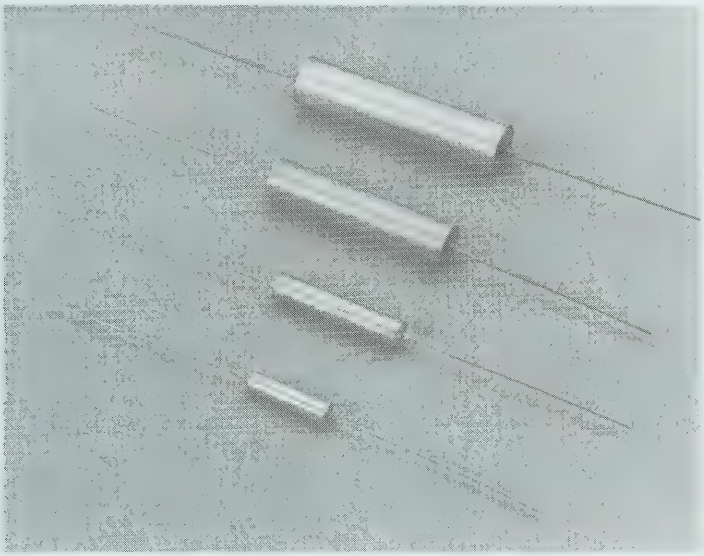
Equivalent Series Resistance



Typical ESR as a function of frequency; case sizes D and F.

SERIES 40NS

Non Polar Solid Electrolyte Tantalum Capacitor



DESCRIPTION

The Philips Components 40NS Series consists of two polar solid electrolyte sintered tantalum anode capacitors, assembled into a tubular metal can in a back-to-back configuration.

Available in four standard sizes, insulated or uninsulated styles, the 40NS Series is manufactured utilizing the highly automated processing and assembly techniques which Philips Components has developed for producing established reliability CSR91 devices to MIL-C-39003.

The 40NS Series is especially adapted for applications involving coupling, filtering, and timing in those computer, industrial, and commercial circuits where AC signals are prevalent, or where voltage reversals are common.

FEATURES

- NON POLAR
- HERMETIC SEAL
- −55°C to 125°C OPERATING
- 6 THRU 100 VOLTS
- 0.0023 uf THRU 160 uf
- FOUR STANDARD SIZES
- COUPLING

SERIES 40NS

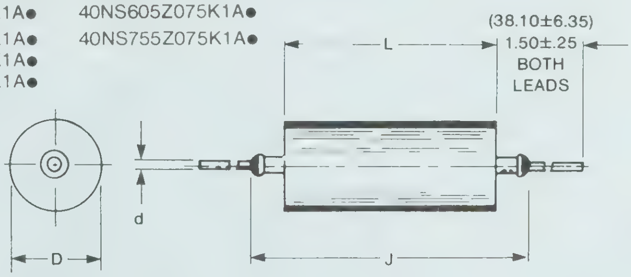
Industrial Type Tantalum Capacitors

PHILIPS COMPONENTS STANDARD RATINGS

CAPACITANCE +25°C 120 Hz	6 WVDC N.P. ±10% INSULATED 4V @ 125°C	10 WVDC N.P. ±10% INSULATED 7V @ 125°C	15 WVDC N.P. ±10% INSULATED 10V @ 125°C	20 WVDC N.P. ±10% INSULATED 13V @ 125°C
0.0023	40NS232W006K1A	40NS232W010K1A	40NS232W015K1A	40NS232W020K1A
0.0028	40NS282W006K1A	40NS282W010K1A	40NS282W015K1A	40NS282W020K1A
0.0034	40NS342W006K1A	40NS342W010K1A	40NS342W015K1A	40NS342W020K1A
0.0041	40NS412W006K1A	40NS412W010K1A	40NS412W015K1A	40NS412W020K1A
0.005	40NS502W006K1A	40NS502W010K1A	40NS502W015K1A	40NS502W020K1A
0.006	40NS602W006K1A	40NS602W010K1A	40NS602W015K1A	40NS602W020K1A
0.0075	40NS752W006K1A	40NS752W010K1A	40NS752W015K1A	40NS752W020K1A
0.009	40NS902W006K1A	40NS902W010K1A	40NS902W015K1A	40NS902W020K1A
0.011	40NS113W006K1A	40NS113W010K1A	40NS113W015K1A	40NS113W020K1A
0.013	40NS133W006K1A	40NS133W010K1A	40NS133W015K1A	40NS133W020K1A
0.016	40NS163W006K1A	40NS163W010K1A	40NS163W015K1A	40NS163W020K1A
0.019	40NS193W006K1A	40NS193W010K1A	40NS193W015K1A	40NS193W020K1A
0.023	40NS233W006K1A	40NS233W010K1A	40NS233W015K1A	40NS233W020K1A
0.028	40NS283W006K1A	40NS283W010K1A	40NS283W015K1A	40NS283W020K1A
0.034	40NS343W006K1A	40NS343W010K1A	40NS343W015K1A	40NS343W020K1A
0.041	40NS413W006K1A	40NS413W010K1A	40NS413W015K1A	40NS413W020K1A
0.05	40NS503W006K1A	40NS503W010K1A	40NS503W015K1A	40NS503W020K1A
0.06	40NS603W006K1A	40NS603W010K1A	40NS603W015K1A	40NS603W020K1A
0.075	40NS753W006K1A	40NS753W010K1A	40NS753W015K1A	40NS753W020K1A
0.09	40NS903W006K1A	40NS903W010K1A	40NS903W015K1A	40NS903W020K1A
0.11	40NS114W006K1A	40NS114W010K1A	40NS114W015K1A	40NS114W020K1A
0.13	40NS134W006K1A	40NS134W010K1A	40NS134W015K1A	40NS134W020K1A
0.16	40NS164W006K1A	40NS164W010K1A	40NS164W015K1A	40NS164W020K1A
0.19	40NS194W006K1A	40NS194W010K1A	40NS194W015K1A	40NS194W020K1A
0.23	40NS234W006K1A	40NS234W010K1A	40NS234W015K1A	40NS234W020K1A
0.28	40NS284W006K1A	40NS284W010K1A	40NS284W015K1A	40NS284W020K1A
0.34	40NS344W006K1A	40NS344W010K1A	40NS344W015K1A	40NS344W020K1A
0.41	40NS414W006K1A	40NS414W010K1A	40NS414W015K1A	40NS414W020K1A
0.5	40NS504W006K1A	40NS504W010K1A	40NS504W015K1A	40NS504W020K1A
0.6	40NS604W006K1A	40NS604W010K1A	40NS604W015K1A	40NS604W020K1A●
0.75	40NS754W006K1A	40NS754W010K1A	40NS754W015K1A	40NS754W020K1A●
0.9	40NS904W006K1A	40NS904W010K1A	40NS904W015K1A	40NS904W020K1A●
1.1	40NS115W006K1A	40NS115W010K1A	40NS115W015K1A	40NS115W020K1A●
1.3	40NS135W006K1A	40NS135W010K1A	40NS135W015K1A●	40NS135X020K1A
1.6	40NS165W006K1A	40NS165W010K1A	40NS165W015K1A●	40NS165X020K1A
1.9	40NS195W006K1A	40NS195W010K1A●	40NS195X015K1A	40NS195X020K1A
2.3	40NS235W006K1A	40NS235W010K1A●	40NS235X015K1A	40NS235X020K1A
2.8	40NS285W006K1A●	40NS285X010K1A	40NS285X015K1A	40NS285X020K1A
3.4	40NS345W006K1A●	40NS345X010K1A	40NS345X015K1A	40NS345X020K1A
4.1	40NS415X006K1A	40NS415X010K1A	40NS415X015K1A	40NS415X020K1A●
5.0	40NS505X006K1A	40NS505X010K1A	40NS505X015K1A	40NS505X020K1A●
6.0	40NS605X006K1A	40NS605X010K1A	40NS605X015K1A	40NS605X020K1A●
7.5	40NS755X006K1A	40NS755X010K1A	40NS755X015K1A	40NS755X020K1A●
9	40NS905X006K1A	40NS905X010K1A	40NS905X015K1A●	40NS905Y020K1A
11	40NS116X006K1A	40NS116X010K1A	40NS116X015K1A●	40NS116Y020K1A
13	40NS136X006K1A	40NS136X010K1A●	40NS136Y015K1A	40NS136Y020K1A●
16	40NS166X006K1A	40NS166X010K1A●	40NS166Y015K1A	40NS166Y020K1A●
19	40NS196X006K1A	40NS196X010K1A●	40NS196Y015K1A	40NS196Y020K1A●
23	40NS236X006K1A●	40NS236Y010K1A	40NS236Y015K1A	40NS236Y020K1A●
28	40NS286X006K1A●	40NS286Y010K1A	40NS286Y015K1A●	40NS286Z020K1A●
34	40NS346Y006K1A	40NS346Y010K1A	40NS346Y015K1A●	40NS346Z020K1A●
41	40NS416Y006K1A	40NS416Y010K1A●	40NS416Z015K1A	40NS416Z020K1A●
50	40NS506Y006K1A	40NS506Y010K1A●	40NS506Z015K1A	40NS506Z020K1A●
60	40NS606Y006K1A	40NS606Y010K1A●	40NS606Z015K1A●	
75	40NS756Y006K1A●	40NS756Z010K1A	40NS756Z015K1A●	
90	40NS906Y006K1A●	40NS906Z010K1A●		
110	40NS117Z006K1A	40NS117Z010K1A●		
130	40NS137Z006K1A●			
160	40NS167Z006K1A●			

● EQUIVALENT VALUE AVAILABLE
CSR91 STYLE PER MIL-C-39003

CAPACITANCE +25°C 120 Hz	35 WVDC N.P. ±10% INSULATED 23V @ 125°C	50 WVDC N.P. ±10% INSULATED 33 V @ 125°C	75 WVDC N.P. ±10% INSULATED 50V @ 125°C	100 WVDC N.P. ±10% INSULATED 67V @ 125°C
0.0023	40NS232W035K1A	40NS232W050K1A●	40NS232W075K1A	40NS232W100K1A●
0.0028	40NS282W035K1A	40NS282W050K1A●	40NS282W075K1A	40NS282W100K1A●
0.0034	40NS342W035K1A	40NS342W050K1A●	40NS342W075K1A	40NS342W100K1A●
0.0041	40NS412W035K1A	40NS412W050K1A●	40NS412W075K1A	40NS412W100K1A●
0.005	40NS502W035K1A	40NS502W050K1A●	40NS502W075K1A	40NS502W100K1A●
0.006	40NS602W035K1A	40NS602W050K1A●	40NS602W075K1A	40NS602W100K1A●
0.0075	40NS752W035K1A	40NS752W050K1A●	40NS752W075K1A	40NS752W100K1A●
0.009	40NS902W035K1A	40NS092W050K1A●	40NS902W075K1A	40NS902W100K1A●
0.011	40NS113W035K1A	40NS113W050K1A●	40NS113W075K1A	40NS113W100K1A●
0.013	40NS133W035K1A	40NS133W050K1A●	40NS133W075K1A	40NS133W100K1A●
0.016	40NS163W035K1A	40NS163W050K1A●	40NS163W075K1A	40NS163W100K1A●
0.019	40NS193W035K1A	40NS193W050K1A●	40NS193W075K1A	40NS193W100K1A●
0.023	40NS233W035K1A	40NS233W050K1A●	40NS233W075K1A	40NS233W100K1A●
0.028	40NS283W035K1A	40NS283W050K1A●	40NS283W075K1A	40NS283W100K1A●
0.034	40NS343W035K1A	40NS343W050K1A●	40NS343W075K1A	40NS343W100K1A●
0.041	40NS413W035K1A	40NS413W050K1A●	40NS413W075K1A	40NS413W100K1A●
0.05	40NS503W035K1A	40NS503W050K1A●	40NS503W075K1A	40NS503W100K1A●
0.06	40NS603W035K1A	40NS603W050K1A●	40NS603W075K1A	40NS603W100K1A●
0.075	40NS753W035K1A	40NS753W050K1A●	40NS753W075K1A	40NS753W100K1A●
0.09	40NS903W035K1A	40NS903W050K1A●	40NS903W075K1A	40NS903W100K1A●
0.11	40NS114W035K1A	40NS114W050K1A●	40NS114W075K1A	40NS114W100K1A●
0.13	40NS134W035K1A	40NS134W050K1A●	40NS134W075K1A	40NS134W100K1A●
0.16	40NS164W035K1A	40NS164W050K1A●	40NS164W075K1A	40NS164W100K1A●
0.19	40NS194W035K1A	40NS194W050K1A●	40NS194W075K1A	40NS194W100k1A●
0.23	40NS234W035K1A	40NS234W050K1A●	40NS234W075K1A	40NS234W100K1A●
0.28	40NS284W035K1A	40NS284W050K1A●	40NS284W075K1A	40NS284W100K1A●
0.34	40NS334W035K1A	40NS344W050K1A●	40NS334W075K1A	40NS334X100K1A●
0.41	40NS414W035K1A	40NS414W050K1A●	40NS414X075K1A	40NS414X100K1A●
0.50	40NS504W035K1A	40NS504W050K1A●	40NS504X075K1A	40NS504X100K1A●
0.60	40NS604X035K1A	40NS604X050K1A●	40NS604X075K1A	40NS604X100K1A●
0.75	40NS754X035K1A	40NS754X050K1A●	40NS754X075K1A	40NS754X100K1A●
0.90	40NS904X035K1A	40NS904X050K1A●	40NS904X075K1A●	
1.1	40NS115X035K1A	40NS115X050K1A●	40NS115X075K1A	40NS115X100K1A●
1.3	40NS135X035K1A	40NS135X050K1A●	40NS135X075K1A	40NS135X100K1A●
1.6	40NS165X035K1A	40NS165X050K1A●	40NS165X075K1A●	
1.9	40NS195X035K1A	40NS195X050K1A●	40NS195X075K1A●	
2.3	40NS235X035K1A	40NS235X050K1A●	40NS235Y075K1A	
2.8	40NS285X035K1A●	40NS285Y050K1A●	40NS285Y075K1A	
3.4	40NS345X035K1A●	40NS345Y050K1A●	40NS345Y075K1A	
4.1	40NS415Y035K1A	40NS415Y050K1A●	40NS415Y075K1A●	
5.0	40NS505Y035K1A	40NS505Y050K1A●	40NS505Y075K1A●	
6.0	40NS605Y035K1A	40NS605Y050K1A●	40NS605Z075K1A●	
7.5	40NS755Y035K1A	40NS755Y050K1A●	40NS755Z075K1A●	
9.0	40NS905Y035K1A	40NS905Y050K1A●		
11	40NS116Y035K1A●	40NS116Z050K1A●		
13	40NS136Z035K1A●			
16	40NS166Z035K1A●			
19	40NS196Z035K1A●			
23	40NS236Z035K1A●			



DIMENSIONS — INCHES (mm)						
	Insulated		Uninsulated		d	
Case Size	D+0.010 (.25) −.015 (.38)	L±.031 (.79)	D±.010 (.25)	L±.031 (.79)	Lead Diam. ±.002 (0.05)	J. Max.
W	0.161 (4.09)	0.575 (14.61)	0.150 (3.81)	0.565 (14.35)	0.020 (0.51)	0.750 (19.05)
X	0.207 (5.26)	0.955 (24.26)	0.199 (5.05)	0.925 (23.50)	0.020 (0.51)	1.130 (28.70)
Y	0.314 (7.98)	1.350 (34.29)	0.305 (7.75)	1,345 (34.25)	0.025 (0.64)	1.525 (38.74)
Z	0.376 (9.55)	1.550 (39.37)	0.368 (9.37)	1.555 (39.41)	0.025 (0.64)	1.725 (43.82)

SERIES 40NS

Industrial Type Tantalum Capacitors

DESIGN AND CONSTRUCTION

Each 40NS type capacitor consists of a highly purified sintered tantalum anode body, utilizing an electrolytically formed oxide dielectric and a solid electrolyte, soldered in a metal case. Two individual metal cases are then connected back-to-back in a metal sleeve.

INSULATION

When specified, a MYLAR* sleeve will be placed over the metal can. The insulation will not soften or creep over the operating temperature range.

RADIAL CONFIGURATION

When radial lead configuration is desired, the negative lead can be bent down the side of the metal can.

LEADS

Lead material is Grade A nickel, tin lead plated to facilitate soldering. Other lead material available on request.

MARKING

Capacitors will be marked with Philips Components part marking capacitance, voltage, and + signs for polarity as a minimum. Nonpolarity is noted by the + on each end. When space permits, capacitance tolerance and date code will be added.

DC WORKING VOLTAGE

40NS Series capacitors are available in 8 voltage ratings applicable from −55°C to 85°C without derating, and to 125°C with 2/3 linear derating (see chart under para. 3). This voltage may be applied in either direction.

These capacitors may be operated with AC only applied. Consult the Philips Components Sales Engineerings Dept. for your specific application.

SURGE VOLTAGE

The surge voltage is the maximum DC voltage, including peak AC or other pulses, which may be applied for short duration.

In no case shall the sum of AC voltage and applied DC working voltage exceed the working voltage of the capacitor.

*Copyright, DuPont Company

The surge voltages are as follows:

Rated WVDC up to 85°C	Derated 125°C	SURGE VOLTAGE 85°C	SURGE VOLTAGE 125°C
6	4	8	5
10	7	13	9
15	10	20	12
20	13	26	16
35	23	46	28
50	33	65	40
75	50	97	64
100	66	130	86

CAPACITANCE

Capacitance shall be measured on a polarized bridge, at or referred to 120 cps at 25°C. The maximum DC bias shall be 2.2VDC for all A.C. measurements. The magnitude of the A.C. signal shall be limited to 1.0 VRMS.

The capacitance so determined shall be within specified initial capacitance tolerance.

TOLERANCE

The 40NS Series is available in ±20%, ±10% and ±5% capacitance tolerance.

DISSIPATION FACTOR

DF shall be measured on a polarized bridge, at or referred to 120 cps at 25°C. The maximum DC bias shall be 2.2 VDC for all A.C. measurements. The magnitude of the A.C. signal shall be limited to 1.0 VRMS.

The DF so determined shall not exceed:

0.01 uf to 68 uf	6% DF maximum
82 uf to 180 uf	8% DF maximum
220 and up	10% DF maximum

D.C. LEAKAGE CURRENT

DCL shall not exceed 0.04 uA/ufV, but need not be less than 1 uA when determined with a 1000 ohm current limiting resistor in series with the test capacitor after a 5 minute application of rated voltage at 25°C. The DCL at 85° shall not exceed 10 times the 25°C limits. At 125°C the DCL shall not exceed 12 times the 25°C limits.

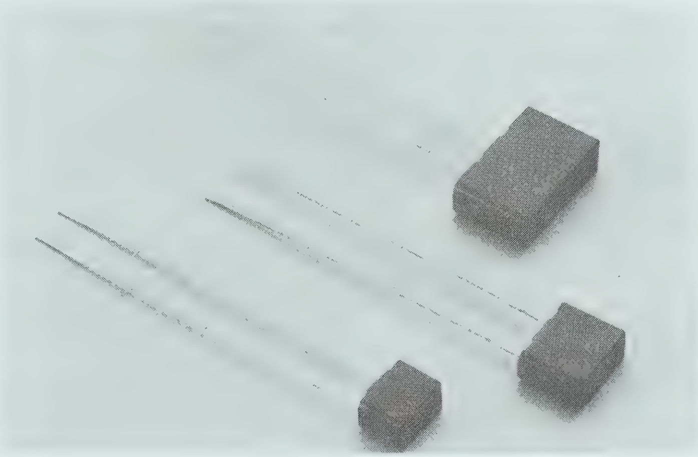
PART NUMBER SYSTEM

EXAMPLE 4 0 N S 165 X 035 K 1 A

- A — INDUSTRIAL
- 1 — 0 = UNSLEEVED; 1 = SLEEVED
- K — CAPACITANCE TOLERANCE: J = ±5% K = ±10% M = ±20%
- 035 — RATED VOLTAGE @ 85°C
- X — CASE SIZE
- 165 — CAPACITANCE IN PICOFARADS. First two digits are significant figures. This is number of zeros to follow: 165 = 1.6 uF; 166 = 16 uF
- S — SOLID ELECTROLYTE
- N — SERIES
- 0 — AXIAL LEAD
- 4 — TANTALUM CAPACITOR

SERIES 41PS

Rectangular Solid Electrolyte Tantalum Capacitor

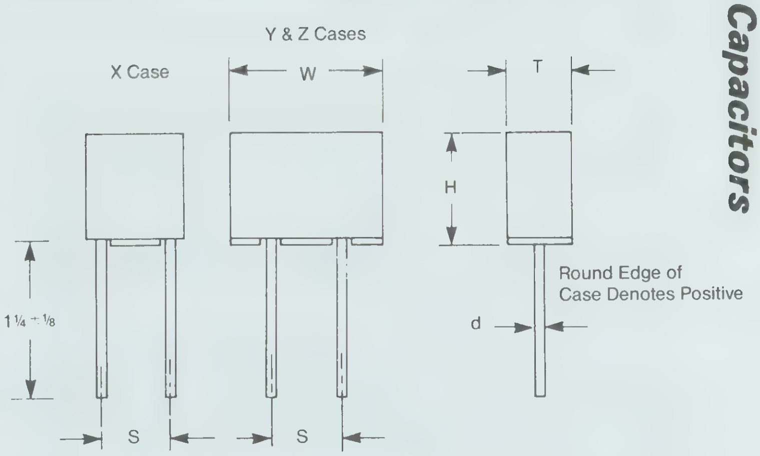


DESCRIPTION

The Philips Components 41PS Series is a solid electrolyte sintered tantalum anode capacitor body, molded into a rectangular epoxy resin package.

Available in three sizes, the 41PS Series is manufactured utilizing the highly automated processing and assembly techniques which were developed for producing established reliability devices.

The 41PS Series offers consistent precision dimensions, precision lead spacing, higher microfarad per cubic inch, and a very low D.C. leakage current and dissipation factor.



Note: Positive indicated by Red Dot on top of Case

DIMENSIONS 41PS TYPE — INCHES (mm)					
CASE SIZE	±.015 (0.4) W	±.015(0.4) H	±.015(0.4) T	±.001(0.02) d	±.005(0.1) S
X	.285(7.2)	.225(5.7)	.170(4.3)	.025(0.6)	.200(5.1)
Y	.360(9.2)	.325(8.3)	.170(4.3)	.025(0.6)	.200(5.1)
Z	.600(15.2)	.375(9.5)	.195(4.9)	.025(0.6)	.200(5.1)

SERIES 41PS

Industrial Type Tantalum Capacitors

ELECTRICAL SPECIFICATION

CAPACITANCE

Type 41PS capacitors are measured on a polarized capacitance bridge. The measurements are made at, or referred to, 120 cps and 25°C conditions. The AC measuring signal shall be limited to 2 volts peak and have a frequency of 120 cps. The bridge shall have a DC polarizing voltage large enough to prevent a reversal of polarity by the AC measuring voltage and at the same time the peak AC should not exceed the rated DC working voltage of the capacitor.

DISSIPATION FACTOR

The low D.F. of the 41PS type capacitors, even at the extremes of the operating temperature range, is another very useful characteristic. Dissipation factor is read directly on most capacitance bridges when making the capacitance measurement discussed above. However, some bridges read ESR (Equivalent Series Resistance) in place of dissipation factor in which case the following formula is applicable — $D.F. = 2\pi fRC$. "R" is the equivalent series resistance. All measurements are made at or referred to a frequency of 120 cps.

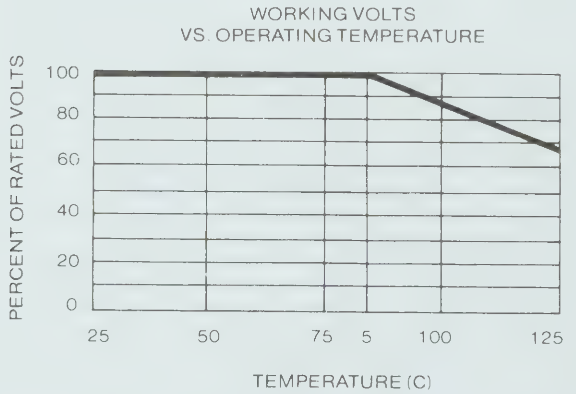
D.C. LEAKAGE

The leakage current when measured after 5 minutes at rated working voltage shall not exceed the DC leakage current limits of .02 ua/uFV or 1.0 ua whichever is greater at 25°C. A 1000 current limiting resistor should be placed in series with the capacitor during DC leakage current measurement.

At 85°C the maximum leakage will be 10 times the 25°C maximum. At 125°C the maximum leakage will not exceed 12.5 times the 25°C maximum.

D.C. WORKING VOLTAGE

The 41PS type tantalum capacitors are available in 8 voltage ratings and may be operated at full rated voltage from −80°C to +85°C. The 41PS type may be further operated up to 125°C by derating the DC working voltage in accordance with the following graph and chart:



SURGE VOLTAGE

The surge voltage rating (see table above) of the Type 41PS capacitor is the maximum short duration voltage which may be applied to the capacitor, i.e. "turn on" transients, peak AC voltage or any other voltage pulses which may be superimposed on the rated DC working voltage.

In no case may the sum of the AC voltage and the applied DC working voltage exceed the rated DC surge voltage.

Rated DC Working Voltage		Rated DC Surge Voltage	
−55 to 85 C	125 C	Up to 85 C	125 C
6	4	8	5
10	7	13	9
15	10	20	12
25	17	33	22
35	23	46	28
50	33	65	40

PHYSICAL SPECIFICATIONS

TEMPERATURE RANGE

Type 41PS will operate from -55° to 85°C without derating. When properly derated. reliable operation is possible up to 125°C.

VIBRATION

The capacitors shall be rigidly mounted by suitable case clamps and subjected to a simple harmonic motion having a maximum amplitude of 0.03" or 15G in 2 mutually perpendicular directions — -1 parallel and 1 perpendicular to the cylindrical axis. Capacitors shall withstand vibration from 10 to 10,000 cycles at 15G without internal damage. The frequency shall be varied uniformly over a frequency range of 55-2000 cps in approximately 20 minutes at a uniform rate for a total of 4 hours. During the last ½ hour of test the test units will be monitored by an instrument capable of detecting intermittent open or short circuits with a duration of .5 milliseconds or greater. Rated DC voltage will be applied to the units during test.

After vibration the capacitors shall meet the initial requirements of dissipation factor and leakage current. The capacitance shall not change more than ±5% from the initial measured value.

LEAD MATERIAL

Standard construction will include tin lead plated nickel leads for soldering. Plain nickel leads are also available for welding.

TERMINAL STRENGTH

With the body of the capacitor secured, the leads shall withstand a 3 lb. load applied in any direction for 30 seconds.

MARKING

Capacitors will be marked with Philips Components part marking capacitance, voltage and polarity as a minimum. Where space permits, capacitance tolerance, & date code, will be added in that sequence, with red dot on top of case indicating polarity.

SERIES 41PS

Industrial Type Tantalum Capacitors

PART NUMBER SYSTEM

4 1 P S 106 X 010 K 0 A

- A — INDUSTRIAL
- 0 — UNSLEEVED
- K — CAPACITANCE TOLERANCE
  J = ±5% K = ±10% M = ±20%
- 010 — VOLTAGE RATING AT 85 C
- X — CASE SIZE
- 106 — CAPACITANCE IN PICOFARADS
  First two digits are significant figures
  Third digit number of zeros to follow
  Ex: 106 = 10 uF
  107 = 100 uF
- S — SOLID ELECTROLYTE
- P — SERIES
- 1 — RADIAL LEAD
- 4 — TANTALUM CAPACITOR

Capacitance uf 25°C 120 cps	Philips Components Part Number ±10%	Maximum Dissipation Factor, % 25°C 120 cps
6 VOLT RATING AT 85°C		
1.0	41PS105X006K0A	6
1.2	41PS125X006K0A	6
1.5	41PS155X006K0A	6
1.8	41PS185X006K0A	6
2.2	41PS225X006K0A	6
2.7	41PS275X006K0A	6
3.3	41PS335X006K0A	6
3.9	41PS395X006K0A	6
4.7	41PS475X006K0A	6
5.6	41PS565X006K0A	6
6.8	41PS685X006K0A	6
8.2	41PS825X006K0A	6
10	41PS106X006K0A	6
12	41PS126X006K0A	6
15	41PS156X006K0A	6
18	41PS186X006K0A	6
22	41PS226X006K0A	6
27	41PS276Y006K0A	8
33	41PS336Y006K0A	8
39	41PS396Y006K0A	8
47	41PS476Y006K0A	8
56	41PS566Y006K0A	8
68	41PS686Y006K0A	8
82	41PS826Z006K0A	8
100	41PS107Z006K0A	8
120	41PS127Z006K0A	8
150	41PS157Z006K0A	8
180	41PS187Z006K0A	8
220	41PS227Z006K0A	10

Capacitance uf 25 C 120 cps	Philips Components Part Number ±10%	Maximum Dissipation Factor, % 25 C 120 cps
10 VOLT RATING AT 85 C		
1.0	41PS105X010K0A	6
1.2	41PS125X010K0A	6
1.5	41PS155X010K0A	6
1.8	41PS185X010K0A	6
2.2	41PS225X010K0A	6
2.7	41PS275X010K0A	6
3.3	41PS335X010K0A	6
3.9	41PS395X010K0A	6
4.7	41PS475X010K0A	6
5.6	41PS565X010K0A	6
6.8	41PS685X010K0A	6
8.2	41PS825X010K0A	6
10	41PS106X010K0A	6
12	41PS126X010K0A	6
15	41PS156Y010K0A	6
18	41PS186Y010K0A	6
22	41PS226Y010K0A	6
27	41PS276Y010K0A	6
33	41PS336Y010K0A	8
39	41PS396Y010K0A	8
47	41PS476Z010K0A	8
56	41PS566Z010K0A	8
68	41PS686Z010K0A	8
82	41PS826Z010K0A	8
100	41PS107Z010K0A	8
120	41PS127Z010K0A	8
150	41PS157Z010K0A	8

SERIES 41PS

Industrial Type Tantalum Capacitors

Capacitance uf 25°C 120 cps	Philips Components Part Number ±10%	Maximum Dissipation Factor, % 25°C 120 cps
15 VOLT RATING AT 85 C		
1.0	41PS105X015K0A	6
1.2	41PS125X015K0A	6
1.5	41PS155X015K0A	6
1.8	41PS185X015K0A	6
2.2	41PS225X015K0A	6
2.7	41PS275X015K0A	6
3.3	41PS335X015K0A	6
3.9	41PS395X015K0A	6
4.7	41PS475X015K0A	6
5.6	41PS565X015K0A	6
6.8	41PS685X015K0A	6
8.2	41PS825X015K0A	6
10	41PS106Y015K0A	6
12	41PS126Y015K0A	6
15	41PS156Y015K0A	6
18	41PS186Y015K0A	6
22	41PS226Y015K0A	6
27	41PS276Y015K0A	6
33	41PS336Z015K0A	8
39	41PS396Z015K0A	8
47	41PS476Z015K0A	8
56	41PS566Z015K0A	8
68	41PS686Z015K0A	8
82	41PS826Z015K0A	8

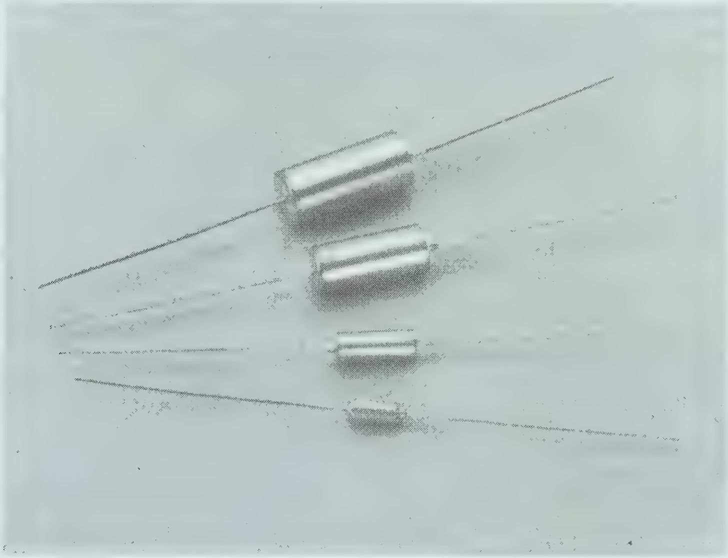
Capacitance uf 25°C 120 cps	Philips Components Part Number ±10%	Maximum Dissipation Factor, % 25°C 120 cps
25 VOLT RATING AT 85 C		
1.0	41PS105X025K0A	6
1.2	41PS125X025K0A	6
1.5	41PS155X025K0A	6
1.8	41PS185X025K0A	6
2.2	41PS225X025K0A	6
2.7	41PS275X025K0A	6
3.3	41PS335X025K0A	6
3.9	41PS395X025K0A	6
4.7	41PS475X025K0A	6
5.6	41PS565Y025K0A	6
6.8	41PS685Y025K0A	6
8.2	41PS825Y025K0A	6
10	41PS106Y025K0A	6
12	41PS126Y025K0A	6
15	41PS156Y025K0A	6
18	41PS186Z025K0A	6
22	41PS226Z025K0A	6
27	41PS276Z025K0A	6
33	41PS336Z025K0A	6
39	41PS396Z025K0A	6
47	41PS476Z025K0A	6

Capacitance uf 25°C 120 cps	Philips Components Part Number ±10%	Maximum Dissipation Factor, % 25 C 120 cps
35 VOLT RATING AT 85 C		
10	41PS104X035K0A	6
12	41PS124X035K0A	6
.15	41PS154X035K0A	6
18	41PS184X035K0A	6
22	41PS224X035K0A	6
27	41PS274X035K0A	6
33	41PS334X035K0A	6
39	41PS394X035K0A	6
.47	41PS474X035K0A	6
.56	41PS564X035K0A	6
68	41PS684X035K0A	6
82	41PS824X035K0A	6
1 0	41PS105X035K0A	6
1 2	41PS125X035K0A	6
1 5	41PS155X035K0A	6
1 8	41PS185X035K0A	6
2 2	41PS225X035K0A	6
2 7	41PS275X035K0A	6
3 3	41PS335X035K0A	6
3 9	41PS395Y035K0A	6
4.7	41PS475Y035K0A	6
5.6	41PS565Y035K0A	6
6 8	41PS685Y035K0A	6
8 2	41PS825Y035K0A	6
10	41PS106Y035K0A	6
12	41PS126Z035K0A	6
15	41PS156Z035K0A	6
18	41PS186Z035K0A	6
22	41PS226Z035K0A	6
27	41PS276Z035K0A	6
33	41PS336Z035K0A	6

Capacitance uf 25 C 120 cps	Philips Components Part Number ±10%	Maximum Dissipation Factor, % 25°C 120 cps
50 VOLT RATING AT 85 C		
.10	41PS104X050K0A	6
.12	41PS124X050K0A	6
.15	41PS154X050K0A	6
.18	41PS184X050K0A	6
.22	41PS224X050K0A	6
.27	41PS274X050K0A	6
.33	41PS334X050K0A	6
.39	41PS394X050K0A	6
.47	41PS474X050K0A	6
.56	41PS564X050K0A	6
.68	41PS684X050K0A	6
.82	41PS824X050K0A	6
1.0	41PS105X050K0A	6
1.2	41PS125X050K0A	6
1.5	41PS155X050K0A	6
1.8	41PS185X050K0A	6
2.2	41PS225X050K0A	6
2.7	41PS275Y050K0A	6
3.3	41PS335Y050K0A	6
3.9	41PS395Y050K0A	6
4.7	41PS475Y050K0A	6
5.6	41PS565Y050K0A	6
6.8	41PS685Z050K0A	6
8.2	41PS825Z050K0A	6
10	41PS106Z050K0A	6
12	41PS126Z050K0A	6
15	41PS156Z050K0A	6
18	41PS186Z050K0A	6

SERIES 40SS

Solid Electrolyte Tantalum Capacitor



DESCRIPTION

The 40SS type solid tantalum capacitors are products of extensive research and development activities. While their unique design makes the 40SS type capacitors extremely stable over a wide temperature range, their high purity, porous sintered tantalum anode and highly refined tantalum oxide dielectric result in capacitors with low DC leakage currents and low dissipation factor values.

FEATURES

- HERMETIC SEAL
- LOWEST DC LEAKAGE CURRENT
- REDUCED ESR RESULTING IN LOW DISSIPATION FACTOR
- MINIMAL CHANGE IN CAPACITANCE AT TEMPERATURE EXTREMES
- HERMETIC DEVICE

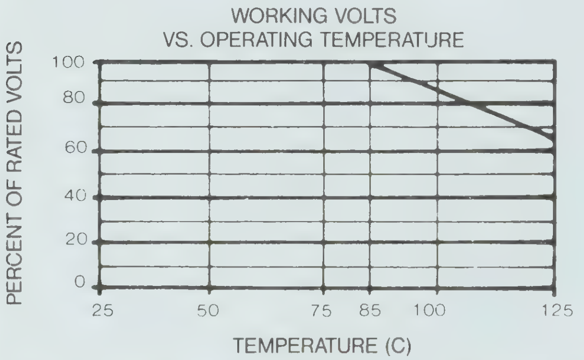
SERIES 40SS

Industrial Type Tantalum Capacitors

ELECTRICAL CHARACTERISTICS

DC WORKING VOLTAGE

40SS Type Tantalum Capacitors are available in 8 voltage ratings and may be operated at full rated voltage from 80°C to +85°C. The "S" type may be further operated up to 125°C by derating the DC working voltage in accordance with the following graph and chart:



Rated DC Working Voltage Up to 85°C	125°C	Rated DC Surge Voltage Up to 85°C	125°C
6	4	8	5
10	7	13	9
15	10	20	12
20	13	26	16
35	23	46	28
50	33	65	40
75	50	97	64
100	66	130	86

SURGE VOLTAGE

The surge voltage rating (see table above) of the 40SS Type capacitor is the maximum short duration voltage which may be applied to the capacitor; i.e., "turn on" transients, peak AC voltage, or any other voltage pulses which may be superimposed on the rated DC working voltage.

In no case may the sum of the AC voltage and the applied DC working voltage exceed the rated DC surge voltage.

SURGE VOLTAGE TEST

Appropriate surge voltage shall be applied to the test capacitor(s) through a 1000 ohm series limiting resistor for 30 seconds. The test capacitors shall then be discharged through the 1000 ohm resistor for 5½ minutes. This charge discharge cycle shall be repeated 2000 times.

Following the surge test the following requirements must be met:

A. Capacitance shall not change more than ±5%.
B. Dissipation Factor shall meet initial requirements.
C. DC Leakage Current shall meet initial requirements.

CAPACITANCE RATINGS

The 40SS Type Capacitors are available from .0047 MFD to 330 MFD in an incremental series of nominal values so chosen that the minimum and maximum allowable tolerance of two successive ratings overlap. In the tabulation of standard ratings you will find nominal ratings for ±10% tolerance series.

Intermediate values for a ±5% and ±20% tolerance series are available on special order.

CAPACITANCE MEASUREMENT

40SS Type capacitors are measured on a polarized capacitance bridge. The measurements are made at, or referred to, 120 hz and 25°C conditions. The AC measuring signal shall be limited to 2 volts peak and have a frequency of 120 hz. The bridge shall have a DC polarizing voltage large enough to prevent a reversal of polarity by the AC measuring voltage and at the same time the peak AC measuring voltage and at the same time the peak AC should not exceed the rated DC working voltage of the capacitor.

CAPACITANCE CHANGE WITH TEMPERATURES

One of the most significant characteristics of the "40SS" Type Capacitor Series is the relatively small change in capacitance at temperature extremes compared to other types of electrolytic capacitors.

The change in capacitance from the initial 25°C measured capacitance shall not exceed the following percentages:

TEMPERATURE	MAX. CHANGE IN CAPACITANCE
-55°C	10%
+85°C	8%
+125°C	12%

DISSIPATION FACTOR

DF shall be measured on a polarized bridge, at or referred to 120 cps at 25°C. The maximum DC bias shall be 2.2 VDC for all AC measurements. The magnitude of the AC signal shall be limited to 1.0 VRMS.

The DF so determined shall not exceed:

0.01 uf to 56 uf	6% DF maximum
68 uf to 120 uf	8% DF maximum
150 uf and Up	10% DF maximum

D.C. LEAKAGE CURRENT

When measured at 25°C, rated voltage, and after a 5 minute electrification period, the values in no case need be less than 1 uA or .02uA/ufV, whichever is greater. At 85°C the leakage will not exceed 10 times the 25°C limit and at 125°C will not exceed 12 times the 25°C limit.

LIFE TEST

Capacitors shall be life tested for 2000 hours at 85°C or 125°C with the appropriate DC working voltage applied. After life test when measured at 25°C the dissipation factor shall meet the initial requirement. This leakage current shall not be more than 125% of the original requirements and capacitors shall not have changed more than ±10% from the initial value.

PHYSICAL ENVIRONMENTS

The 40SS Type Solid Electrolyte Tantalum Capacitors are capable of meeting the following requirements on environmental test.

In the interest of standardization, these tests follow very closely the testing specified in military specifications on solid tantalums. They do not represent the maximum environment capabilities of the M/C 40SS Type.

For more extreme conditions the M/C Capacitor Engineering Department should be consulted.

LOW FREQUENCY VIBRATION

The capacitors shall be rigidly mounted by suitable case clamps and subjected to a simple harmonic motion having a maximum amplitude of 0.03." The frequency shall be varied uniformly over a frequency range of 10-55 Hz in approximately 1 minute at a uniform rate for a total of 2 hours. Rated DC voltage will be applied to the units during test. During the last ½ hour of test, the test units will be monitored by an instrument capable of detecting intermittent open or short circuits with a duration of .5 milliseconds or greater.

After vibration the capacitors shall meet the initial requirements of dissipation factor and leakage current. The capacitance shall not change more than ±5% from the initial measured value.

HIGH FREQUENCY VIBRATION

The capacitors shall be rigidly mounted by suitable case clamps and subjected to a simple harmonic motion having a maximum amplitude of 0.03" or 15G in 2 mutually perpendicular directions—1 parallel and 1 perpendicular to the cylindrical axis. Capacitors shall withstand vibration from 10 to 10,000 Hz at 15g without internal damage. The frequency shall be varied uniformly over a frequency range (f55-2000 Hz in approximately 20 minutes at a uniform rate for a total of 4 hours. During the last ½ hour of test the test units will be monitored by an instrument capable of detecting intermittent open or short circuits with a duration of .5 milli-seconds or greater. Rated DC voltage will be applied to the units during test.

After vibration the capacitors shall meet the initial requirements of dissipation factor and leakage current. The capacitance shall not change more than ±5% from the initial measured value.

PULL TEST

With the body of the capacitor secured, the leads shall withstand a 3 lb. load applied in any direction for 30 seconds.

BEND TEST

Each capacitor lead shall be capable of withstanding 5 bends. A bend shall be defined as follows:

With the capacitor vertical and a 1 lb. weight attached to the lead, the capacitor body shall be slowly rotated (in approximately 5 seconds) to a horizontal position and then rotated to the vertical position. The 4 succeeding bends shall then be made in the same manner but in alternate directions.

MOISTURE RESISTANCE

40SS type capacitors shall be tested in accordance with method 106 of MIL Standard 202. The following details and exceptions shall apply:

a. Mounting—The capacitors shall be securely mounted by normal mounting means during the test. This does not apply during measurements.
b. Initial measurements are not applicable.
c. Polarization and loading voltages are not applicable during the test.
d. Final Measurements—With 2-6 hours after the capacitors have been removed from the humidity chamber following the final cycle, the DC leakage, capacitance and dissipation factor shall be measured as specified.
e. Examinations After Test—Following the final measurements the capacitors shall be examined visually for evidence of corrosion, mechanical damage and obliteration of marking.

INSULATING SLEEVES

For insulated capacitors, the insulating sleeves shall be tested as follows for dielectric strength and insulation resistance.

Two wire windings shall be placed around the insulating sleeves ¼" apart. Each winding to consist of 2 close turns of 24AWG bare copper wire.

DIELECTRIC STRENGTH

For dielectric strength a DC test potential of 2000 V shall be applied for 1 minute between the 2 windings. There shall be no breakdown of case insulation.

INSULATION RESISTANCE

For insulation resistance a DC test potential of 100 V shall be applied for 2 minutes. The insulation resistance shall not be less than 100 megohms.

SHELF LIFE TEST

When the capacitors have been exposed to 5000 hours shelf life test at 85°C with no voltage applied capacitance shall not change more than ±4% from the initial measured value. The dissipation factor shall not exceed 150% of the initial requirement and the leakage current shall meet the initial requirement.

SHOCK

The capacitors shall be tested for shock resistance in accordance with MIL Standard 202A methods 205 with the following exceptions.

a. The capacitors shall be rigidly mounted by suitable body clamps.
b. The capacitor shall be subjected to 20 impacts of 50g with an 11 milli-seconds duration. Ten impacts to be applied in the direction of the longitudinal axis, and 10 impacts in a plane normal to the longitudinal axis of the capacitor.
c. Rated DC voltage shall be applied to the capacitors during the shock test.

The test units shall be monitored during test by an instrument capable of detecting intermittent open and short circuits with a duration of .5 milli-seconds or greater.

After test the capacitors shall meet the initial requirements of capacitance, dissipation factor and leakage requirements.

THERMAL SHOCK AND IMMERSION CYCLING

After the capacitors are tested as specified in 8A and 8B, the DC leakage current shall meet the initial requirement. The capacitance change shall not exceed ±5% of the value measured prior to test and the dissipation factor shall meet the initial requirement. When examined visually, at least 90% of all exposed metallic surfaces shall show no evidence of harmful corrosion. When examined internally there shall be no evidence of dye penetration.

THERMAL SHOCK

Capacitors shall be tested in accordance with Method 107 of MIL Standard 202. The following exceptions and details shall apply:

a. Capacitors should be conditioned at a temperature of 25°C for 15 minutes before the first cycle of test one.
b. The B test condition will be followed except that in the third step thereof, the capacitors will be subjected to a test at the highest applicable temperature.
c. Measurements before and after cycling may be omitted.

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IMMERSION CYCLING

After temperature cycling, a capacitor test should be made following Method 104 set down in MIL Standard 202. The following details and exceptions, however, shall apply:

a. A non-corrosive dye, Rhodamine B (tetraethylrhodamine), or its equivalent, shall be added in both baths in addition to steps provided in test condition B.
b. Measurements after final cycle—Measurements of DC leakage, capacitance and dissipation factor shall be made within 30 minutes after the capacitors are removed from the final immersion bath.
c. Examinations after test—The capacitors shall be visually examined for traces of corrosion, mechanical damage, and obliteration of marking. Capacitors shall then be sectioned for evidence of dye penetration.

REDUCED PRESSURE

After the capacitors have been stabilized for 5 minutes in a vacuum of 1.69×10^{1} Torr., rated DC voltage shall be applied for 1 minute. There shall be no voltage flash over nor shall the end seals show evidence of damage by this test. The capacitance, dissipation factor, and leakage current shall meet the initial requirements.

LEAD MATERIAL

Standard construction will include tin lead plated leads for soldering. Plain nickel leads are also available for welding.

MARKING

Capacitors shall be marked with Philips Components part marking rated capacitance, tolerance, polarity, rated DC working voltage, date code where space permits. Polarity will be marked on one end with a + sign to identify the positive terminal.

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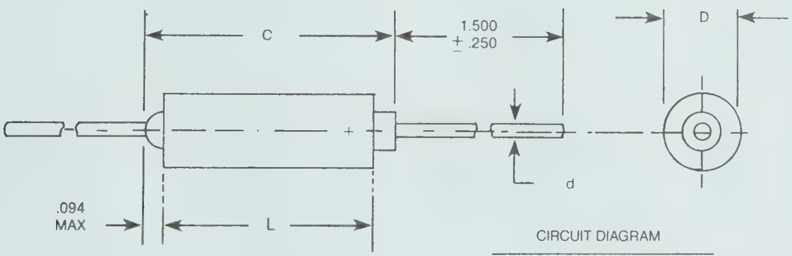
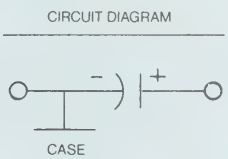
PHILIPS COMPONENTS PART NUMBERING SYSTEM

EXAMPLE:

4 0 S S 105 A 050 K 1 A

- A — COMMERCIAL
- 1 — 0 = UNSLEEVED, 1 = SLEEVED
- K — CAPACITANCE TOLERANCE: J = ±5% K = ±10% M = ±20
- 050 — VOLTAGE RATING @ 85 C
- A — CASE SIZE
- 105 — CAPACITANCE IN PICOFARADS
  First two digits are significant figures
  Third is number of zeros to follow:
  105 = 1.0 uF
  106 = 10 uF
- S — SOLID ELECTROLYTE
- S — SERIES
- 0 — AXIAL LEAD
- 4 — TANTALUM CAPACITOR





DIMENSIONS — INCHES (mm)								
Case Size	Uninsulated		Insulated		C Max.	d Lead Dia. d±002 (0.05)	Lead Length l±.25 (±6.40)	Approx. Weight Grams
	D +.016 (0.41) −.015 (0.38)	L±.031 (.079)	D +.016 (0.41) −.015 (0.38)	L±.031				
A	0.125 (3.18)	0.250 (635)	0.135 (3.43)	0.286 (7.26)	.422 (10.72)	0.020 (0.51)	1.50	0.7
B	0.175 (4.45)	0.438 (11.12)	0.185 (4.70)	0.474 (12.04)	.610 (15.49)	0.020 (0.51)	1.50	1.6
C	0.279 (7.10)	0.650 (16.50)	0.289 (7.34)	0.686 (17.42)	.822 (20.88)	0.025 (0.64)	1.50	4.9
D	0.341 (8.65)	0.750 (19.05)	0.351 (8.92)	0.786 (19.96)	.922 (23.42)	0.025 (0.64)	1.50	8.8

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STANDARD RATINGS

CAPACITANCE +25°C 120Hz	6 WVDC ±10% INSULATED 4V @ 125°C	DCL @ 25°C TYPICAL	10 WVDC ±10% INSULATED 7V @ 125°C	DCL @ 25°C TYPICAL	15 WVDC ±10% INSULATED 10V @ 125°C	DCL @ 25°C TYPICAL	20 WVDC ±10% INSULATED 13V @ 125°C	DCL @ 25°C TYPICAL	μF
0047	40SS472A006K1A	0.1	40SS472A010K1A	0.1	40SS472A015K1A	0 1	40SS472A020K1A	0.1	.0047
0056	40SS562A006K1A	0.1	40SS562A010K1A	0.1	40SS562A015K1A	0 1	40SS562A020K1A	0.1	.0056
0068	40SS682A006K1A	0.1	40SS682A010K1A	0.1	40SS682A015K1A	0 1	40SS682A020K1A	0.1	.0068
.0082	40SS822A006K1A	0 1	40SS822A010K1A	0.1	40SS822A015K1A	0 1	40SS822A020K1A	0.1	.0082
01	40SS103A006K1A	0 1	40SS103A010K1A	0.1	40SS103A015K1A	0 1	40SS103A020K1A	0.1	.01
.012	40SS123A006K1A	0 1	40SS123A010K1A	0.1	40SS123A015K1A	0 1	40SS123A020K1A	0.1	.012
015	40SS153A006K1A	0 1	40SS153A010K1A	0.1	40SS153A015K1A	0 1	40SS153A020K1A	0.1	015
018	40SS183A006K1A	0 1	40SS183A010K1A	0.1	40SS183A015K1A	0 1	40SS183A020K1A	0.1	.018
022	40SS223A006K1A	0 1	40SS223A010K1A	0.1	40SS223A015K1A	0 1	40SS223A020K1A	0.1	.022
027	40SS273A006K1A	0 1	40SS273A010K1A	0.1	40SS273A015K1A	0 1	40SS273A020K1A	0.1	027
033	40SS333A006K1A	0.1	40SS333A010K1A	0.1	40SS333A015K1A	0 1	40SS333A020K1A	0.1	033
039	40SS393A006K1A	0.1	40SS393A010K1A	0.1	40SS393A015K1A	0 1	40SS393A020K1A	0.1	.039
.047	40SS473A006K1A	0.1	40SS473A010K1A	0.1	40SS473A015K1A	0 1	40SS473A020K1A	0.1	.047
056	40SS563A006K1A	0.1	40SS563A010K1A	0.1	40SS563A015K1A	0 1	40SS563A020K1A	0.1	056
068	40SS683A006K1A	0.1	40SS683A010K1A	0.1	40SS683A015K1A	0 1	40SS683A020K1A	0.1	.068
082	40SS823A006K1A	0.1	40SS823A010K1A	0.1	40SS823A015K1A	0 1	40SS823A020K1A	0.1	082
1	40SS104A006K1A	0 5	40SS104A010K1A	0.5	40SS104A015K1A	0 5	40SS104A020K1A	0.5	.1
12	40SS124A006K1A	0 5	40SS124A010K1A	0.5	40SS124A015K1A	0.5	40SS124A020K1A	0.5	.12
15	40SS154A006K1A	0 5	40SS154A010K1A	0.5	40SS154A015K1A	0 5	40SS154A020K1A	0.5	15
18	40SS184A006K1A	0 5	40SS184A010K1A	0.5	40SS184A015K1A	0 5	40SS184A020K1A	0.5	.18
22	40SS224A006K1A	0 5	40SS224A010K1A	0.5	40SS224A015K1A	0 5	40SS224A020K1A	0.5	.22
27	40SS274A006K1A	0 5	40SS274A010K1A	0 5	40SS274A015K1A	0 5	40SS274A020K1A	0 5	.27
33	40SS334A006K1A	0 5	40SS334A010K1A	0.5	40SS334A015K1A	0 5	40SS334A020K1A	0.5	.33
39	40SS394A006K1A	0 5	40SS394A010K1A	0.5	40SS394A015K1A	0 5	40SS394A020K1A	0.5	.39
47	40SS474A006K1A	0 5	40SS474A010K1A	0.5	40SS474A015K1A	0 5	40SS474A020K1A	0.5	.47
56	40SS564A006K1A	0 5	40SS564A010K1A	0.5	40SS564A015K1A	0 5	40SS564A020K1A	0.5	.56
68	40SS684A006K1A	0 5	40SS684A010K1A	0.5	40SS684A015K1A	0 5	40SS684A020K1A	0.5	.68
82	40SS824A006K1A	0 5	40SS824A010K1A	0 5	40SS824A015K1A	0 5	40SS824A020K1A	0.5	82
1 0	40SS105A006K1A	0 5	40SS105A010K1A	0.5	40SS105A015K1A	0 5	40SS105A020K1A	0.5	1.0
1 2	40SS125A006K1A	0 5	40SS125A010K1A	0.5	40SS125A015K1A	0 5	40SS125A020K1A	0.5	1.2
1 5	40SS155A006K1A	0 5	40SS155A010K1A	0.5	40SS155A015K1A	0.5	40SS155A020K1A	0.5	1 5
1 8	40SS185A006K1A	0 5	40SS185A010K1A	0.5	40SS185A015K1A	0 5	40SS185A020K1A	0.5	1.8
2 2	40SS225A006K1A	0 5	40SS225A010K1A	0.5	40SS225A015K1A	0 5	40SS225A020K1A	0.5	2.2
2 7	40SS275A006K1A	0 5	40SS275A010K1A	0.5	40SS275A015K1A	0 5	40SS275B020K1A	0.5	2 7
3 3	40SS335A006K1A	0 5	40SS335A010K1A	0.5	40SS335A015K1A	0.5	40SS335B020K1A	1.0	3.3
3 9	40SS395A006K1A	0 5	40SS395A010K1A	0.5	40SS395B015K1A	0 5	40SS395B020K1A	1.0	3.9
4 7	40SS475A006K1A	0 5	40SS475A010K1A	0.5	40SS475B015K1A	1.0	40SS475B020K1A	1.0	4.7
5 6	40SS565A006K1A	0 5	40SS565B010K1A	0.5	40SS565B015K1A	1.0	40SS565B020K1A	1.0	5.6
6 8	40SS685A006K1A	0 5	40SS685B010K1A	1.0	40SS685B015K1A	1 0	40SS685B020K1A	1.0	6.8
8 2	40SS825A006K1A	0 5	40SS825B010K1A	1.0	40SS825B015K1A	1 0	40SS825B020K1A	1.0	8.2
10	40SS106B006K1A	0 5	40SS106B010K1A	1.0	40SS106B015K1A	1 0	40SS106B020K1A	1.0	10.
12	40SS126B006K1A	0 5	40SS126B010K1A	1.0	40SS126B015K1A	1 0	40SS126B020K1A	2.0	12.
15	40SS156B006K1A	1 0	40SS156B010K1A	1.0	40SS156B015K1A	2.0	40SS156B020K1A	3.0	15.
18	40SS186B006K1A	1 0	40SS186B010K1A	1.0	40SS186B015K1A	2 0	40SS186C020K1A	3.0	18.
22	40SS226B006K1A	1 0	40SS226B010K1A	2.0	40SS226B015K1A	3.0	40SS226C020K1A	3.0	22.
27	40SS276B006K1A	1 0	40SS276B010K1A	2.0	40SS276C015K1A	3 0	40SS276C020K1A	3.0	27.
33	40SS336B006K1A	1 0	40SS336B010K1A	2.0	40SS336C015K1A	3.0	40SS336C020K1A	3.0	33.
39	40SS396B006K1A	1 0	40SS396B010K1A	2.0	40SS396C015K1A	3.0	40SS396C020K1A	3.0	39.
47	40SS476B006K1A	2 0	40SS476C010K1A	3.0	40SS476C015K1A	6 0	40SS476C020K1A	6.0	47.
56	40SS566B006K1A	2 0	40SS566C010K1A	3.0	40SS566C015K1A	6.0	40SS566D020K1A	6.0	56.
68	40SS686C006K1A	3 0	40SS686C010K1A	3.0	40SS686C015K1A	6 0	40SS686D020K1A	6.0	68
82	40SS826C006K1A	3 0	40SS826C010K1A	3.0	40SS826D015K1A	6.0	40SS826D020K1A	6.0	82.
100	40SS107C006K1A	3.0	40SS107C010K1A	6.0	40SS107D015K1A	6.0	40SS107D020K1A	10.0	100
120	40SS127C006K1A	3 0	40SS127C010K1A	6.0	40SS127D015K1A	6 0			
150	40SS157C006K1A	6 0	40SS157D010K1A	10.0	40SS157D015K1A	10.0			
180	40SS187C006K1A	6 0	40SS187D010K1A	10.0					
220	40SS227D006K1A	6 0	40SS227D010K1A	10.0					
270	40SS277D006K1A	6 0							
330	40SS337D006K1A	10 0							

SERIES 40SS

Industrial Type Tantalum Capacitors

STANDARD RATINGS

CAPACITANCE +25°C 120 Hz	35 WVDC ±10% INSULATED 23V @ 125°C	DCL @25°C TYPICAL	50 WVDC ±10% INSULATED 33V @ 125°C	DCL @25°C TYPICAL	75 WVDC ±10% INSULATED 50V @ 125°C	DCL @ 25°C TYPICAL	100 WVDC ±10% INSULATED 67V @ 125°C	DCL @25°C TYPICAL	μF
.0047	40SS472A035K1A	0.1	40SS472A050K1A	0.1	40SS472A075K1A	0.5	40SS472A100K1A	0.5	.0047
.0056	40SS562A035K1A	0.1	40SS562A050K1A	0.1	40SS562A075K1A	0.5	40SS562A100K1A	0.5	.0056
.0068	40SS682A035K1A	0.1	40SS682A050K1A	0.1	40SS682A075K1A	0.5	40SS682A100K1A	0.5	.0068
.0082	40SS822A035K1A	0.1	40SS822A050K1A	0.1	40SS822A075K1A	0.5	40SS822A100K1A	0.5	.0082
.01	40SS103A035K1A	0.1	40SS103A050K1A	0.1	40SS103A075K1A	0.5	40SS103A100K1A	0.5	.01
.012	40SS123A035K1A	0.1	40SS123A050K1A	0.1	40SS123A075K1A	0.5	40SS103A100K1A	0.5	.012
.015	40SS153A035K1A	0.1	40SS153A050K1A	0.1	40SS153A075K1A	0.5	40SS153A100K1A	0.5	.015
.018	40SS183A035K1A	0.1	40SS183A050K1A	0.1	40SS183A075K1A	0.5	40SS183A100K1A	0.5	.108
.022	40SS223A035K1A	0.1	40SS223A050K1A	0.1	40SS223A075K1A	0.5	40SS223A100K1A	0.5	.022
.027	40SS273A035K1A	0.1	40SS273A050K1A	0.1	40SS273A075K1A	0.5	40SS273A100K1A	0.5	.027
.033	40SS333A035K1A	0.1	40SS333A050K1A	0.1	40SS333A075K1A	0.5	40SS333A100K1A	0.5	.033
.039	40SS393A035K1A	0.1	40SS393A050K1A	0.1	40SS393A075K1A	0.5	40SS393A100K1A	0.5	.039
.047	40SS473A035K1A	0.1	40SS473A050K1A	0.1	40SS473A075K1A	0.5	40SS473A100K1A	0.5	.047
.056	40SS563A035K1A	0.1	40SS563A050K1A	0.1	40SS563A075K1A	0.5	40SS563A100K1A	0.5	.056
.068	40SS683A035K1A	0.1	40SS683A050K1A	0.1	40SS683A075K1A	0.5	40SS683A100K1A	0.5	.068
.082	40SS823A035K1A	0.1	40SS823A050K1A	0.1	40SS823A075K1A	0.5	40SS823A100K1A	0.5	.082
.1	40SS104A035K1A	0.5	40SS104A050K1A	0.5	40SS104A075K1A	0.5	40SS104A100K1A	0.5	.1
.12	40SS124A035K1A	0.5	40SS124A050K1A	0.5	40SS124A075K1A	0.5	40SS124A100K1A	0.5	.12
.15	40SS154A035K1A	0.5	40SS154A050K1A	0.5	40SS154A075K1A	0.5	40SS154A100K1A	0.5	.15
18	40SS184A035K1A	0.5	40SS184A050K1A	0.5	40SS184A075K1A	0.5	40SS184A100K1A	0.5	.18
.22	40SS224A035K1A	0.5	40SS224A050K1A	0.5	40SS224A075K1A	0.5	40SS224A100K1A	0.5	.22
.27	40SS274A035K1A	0.5	40SS274A050K1A	0.5	40SS274A075K1A	0.5	40SS274A100K1A	0.5	.27
.33	40SS334A035K1A	0.5	40SS334A050K1A	0.5	40SS334A075K1A	0.5	40SS334A100K1A	0.5	.33
.39	40SS394A035K1A	0.5	40SS394A050K1A	0.5	40SS394A075K1A	0.5	40SS394A100K1A	0.5	.39
.47	40SS474A035K1A	0.5	40SS474A050K1A	0.5	40SS474A075K1A	0.5	40SS474A100K1A	0.5	.47
.56	40SS564A035K1A	0.5	40SS564A050K1A	0.5	40SS564A075K1A	0.5	40SS564A100K1A	0.5	.56
.68	40SS684A035K1A	0.5	40SS684A050K1A	0.5	40SS684A075K1A	0.5	40SS684B100K1A	0.5	.68
82	40SS824A035K1A	0.5	40SS824A050K1A	0.5	40SS824B075K1A	0.5	40SS824B100K1A	0.5	.82
1.0	40SS105A035K1A	0.5	40SS105A050K1A	0.5	40SS105B075K1A	0.5	40SS105B100K1A	0.5	1.0
1.2	40SS125B035K1A	0.5	40SS125B050K1A	0.5	40SS125B075K1A	0.5	40SS125B100K1A	0.5	1.2
1.5	40SS155B035K1A	0.5	40SS155B050K1A	0.5	40SS155B075K1A	1.0	40SS155B100K1A	1.0	1.5
1.8	40SS185B035K1A	0.5	40SS185B050K1A	0.5	40SS185B075K1A	1.0	40SS185B100K1A	1.0	1.8
2.2	40SS225B035K1A	1.0	40SS225B050K1A	1.0	40SS225B075K1A	1.5	40SS225B100K1A	1.5	2.2
2.7	40SS275B035K1A	1.0	40SS275B050K1A	1.0	40SS275B075K1A	1.5	40SS275B100K1A	1.5	2.7
3.3	40SS335B035K1A	1.0	40SS335B050K1A	2.0	40SS335B075K1A	2.0			3.3
3.9	40SS395B035K1A	1.0	40SS395B050K1A	2.0	40SS395B075K1A	2.0			3.9
4.7	40SS475B035K1A	1.0	40SS475B050K1A	3.0	40SS475C075K1A	6.0			4.7
5.6	40SS565B035K1A	1.0	40SS565C050K1A	3.0	40SS565C075K1A	6.0			5.6
6.8	40SS685B035K1A	2.0	40SS685C050K1A	3.0	40SS685C075K1A	10.0			6.8
8.2	40SS825C035K1A	3.0	40SS825C050K1A	3.0	40SS825C075K1A	10.0			
10	40SS106C035K1A	3.0	40SS106C050K1A	3.0	40SS106C075K1A	10.0			10.
12	40SS126C035K1A	3.0	40SS126C050K1A	3.0	40SS126D075K1A	10.0			12.
15	40SS156C035K1A	3.0	40SS156C050K1A	6.0	40SS156D075K1A	12.0			15.
18	40SS186C035K1A	3.0	40SS186C050K1A	6.0					
22	40SS226C035K1A	6.0	40SS226D050K1A	6.0					
27	40SS276D035K1A	6.0							
33	40SS336D035K1A	6.0							
39	40SS396D035K1A	6.0							
47	40SS476D035K1A	10.0							

CASE SIZE — The case size in the tabulation above is indicated by the use of the eighth character in the part number.

SERIES 40TS

Miniature Hermetic Seal Solid Electrolyte Tantalum Capacitor

3

Tantalum Capacitors

DESCRIPTION

Philips Components 40TS is a miniature hermetically sealed solid electrolyte sintered tantalum anode capacitor.

The construction offers an extremely small clean lead to clean lead dimension because the unique integral lead glass-to-metal seal eliminates the usual hermetic seal tubulature. This, combined with special dimensions, makes the 40TS ideal for cordwood packaging.

CONSTRUCTION

Each 40TS capacitor consists of a processed sintered tantalum anode soldered into a metal enclosure and hermetically sealed with an integral lead-glass-to-metal seal. A small amount of red epoxy may be utilized to protect the seal where lead bends are performed close to the positive end of the capacitor. Identical construction as CSR09 of MIL 39003/02.

CAPACITANCE

Capacitances available are 0.0047 uf thru 39 uf in standard EIA decade values. Capacitance is measured at 120 Hz with a maximum of 1 VRMS and 2.2 VDC applied. Measurements are made at 25°C.

DISSIPATION FACTOR

Usually determined simultaneously with capacitance by the bridge method. The DF will generally conform to the following: 6% DF at 25°C, 8% at all other temperatures.

D.C. WORKING VOLTS

The maximum working voltage including ripple can not exceed the rated voltage for each specific capacitor value. Values for all temperatures is as follows,—linear derate applies from 85°C to 125°C:

+85°C		+125°C	
Rated	Surge	Rated	Surge
4	5	3	4
6	8	4	5
10	12	7	9
15	18	10	12
20	24	13	16
35	42	23	28
50	60	33	40
60	69	40	46
75	86	50	58
100	130	67	86

D.C. LEAKAGE CURRENT

DCL shall not exceed 0.02 uA/ufv, but need not be less than 1 uA when determined with a 1000 ohm current limiting resistor in series with the test capacitor after a 5 minute application of rated voltage at 25°C. The DCL at 85°C shall not exceed 10 times the 25°C limits. At 125°C the DCL shall not exceed 12 times the 25°C limits.

FEATURES

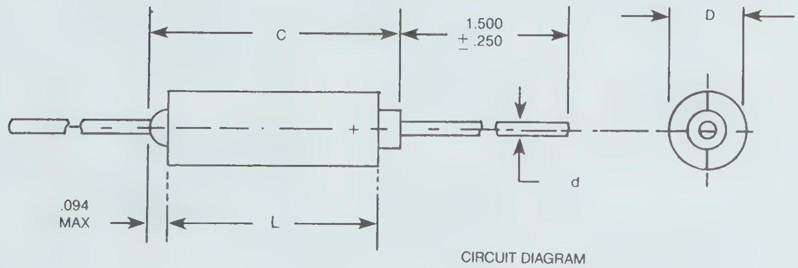
- −80 TO +125°C OPERATION
- 4 THROUGH 100 VDC
- EXCELLENT FOR CORDWOOD PACKAGING
- 2 CASE SIZES

PART NUMBER SYSTEM

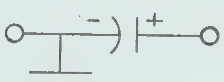
EXAMPLE

4 0 T S 105 T 035 K 1 A

- 4 — TANTALUM CAPACITOR
- 0 — AXIAL LEAD
- T — SERIES
- S — SOLID ELECTROLYTE
- 105 — CAPACITANCE IN PICOFARADS. First two digits are significant figures. Third digit is number of zeros to follow:
  - 105 = 1.0 uF
  - 106 = 10 uF
- T — CASE SIZE
- 035 — RATED VOLTAGE @ 85 C
- K — CAPACITANCE TOLERANCE J = ±5% K = ±10% M = ±20%
- 1 — 0 = UNSLEEVED, 1 = SLEEVED
- A — INDUSTRIAL



CIRCUIT DIAGRAM



DIMENSIONS — INCHES (mm)					
Case Size	Uninsulated		Insulated		Lead Dia. d. +.005 (.01) −.001 (.003)
	D ±.005 (.01)	L ±.005 (.01)	D ±.005 (.01)	L +.031 (.08) −.005 (.01)	
T	0.087 (2.21)	0.235 (6.35)	0.090 (2.29)	0.250 (6.35)	0.016 (0.41)
X	0.125 (3.51)	0.375 (9.55)	0.138 (3.51)	0.390 (9.91)	0.016 (0.41)

SERIES 40TS
Industrial Type Tantalum Capacitors

STANDARD RATINGS

Capacitance	4 WVDC ±10% Insulated	6 WVDC ±10% Insulated	10 WVDC ±10% Insulated	15 WVDC ±10% Insulated
.0047	40TS472T004K1A	40TS472T006K1A	40TS472T010K1A	40TS472T015K1A
.0056	40TS562T004K1A	40TS562T006K1A	40TS562T010K1A	40TS562T015K1A
.0068	40TS682T004K1A	40TS682T006K1A	40TS682T010K1A	40TS682T015K1A
.0082	40TS822T004K1A	40TS822T006K1A	40TS822T010K1A	40TS822T015K1A
.010	40TS103T004K1A	40TS103T006K1A	40TS103T010K1A	40TS103T015K1A
.012	40TS123T004K1A	40TS123T006K1A	40TS123T010K1A	40TS123T015K1A
.015	40TS153T004K1A	40TS153T006K1A	40TS153T010K1A	40TS153T015K1A
.018	40TS183T004K1A	40TS183T006K1A	40TS183T010K1A	40TS183T015K1A
022	40TS223T004K1A	40TS223T006K1A	40TS223T010K1A	40TS223T015K1A
.027	40TS273T004K1A	40TS273T006K1A	40TS273T010K1A	40TS273T015K1A
033	40TS333T004K1A	40TS333T006K1A	40TS333T010K1A	40TS333T015K1A
.039	40TS393T004K1A	40TS393T006K1A	40TS393T010K1A	40TS393T015K1A
.047	40TS473T004K1A	40TS473T006K1A	40TS473T010K1A	40TS473T015K1A
056	40TS563T004K1A	40TS563T006K1A	40TS563T010K1A	40TS563T015K1A
068	40TS683T004K1A	40TS683T006K1A	40TS683T010K1A	40TS683T015K1A
082	40TS823T004K1A	40TS823T006K1A	40TS823T010K1A	40TS823T015K1A
10	40TS104T004K1A	40TS104T006K1A	40TS104T010K1A	40TS104T015K1A
.12	40TS124T004K1A	40TS124T006K1A	40TS124T010K1A	40TS124T015K1A
15	40TS154T004K1A	40TS154T006K1A	40TS154T010K1A	40TS154T015K1A
.18	40TS184T004K1A	40TS184T006K1A	40TS184T010K1A	40TS184T015K1A
.22	40TS224T004K1A	40TS224T006K1A	40TS224T010K1A	40TS224T015K1A
27	40TS274T004K1A	40TS274T006K1A	40TS274T010K1A	40TS274T015K1A
.33	40TS334T004K1A	40TS334T006K1A	40TS334T010K1A	40TS334T015K1A
.39	40TS394T004K1A	40TS394T006K1A	40TS394T010K1A	40TS394T015K1A
47	40TS474T004K1A	40TS474T006K1A	40TS474T010K1A	40TS474T015K1A
.56	40TS564T004K1A	40TS564T006K1A	40TS564T010K1A	40TS564T015K1A
.68	40TS684T004K1A	40TS684T006K1A	40TS684T010K1A	40TS684T015K1A
.82	40TS824T004K1A	40TS824T006K1A	40TS824T010K1A	40TS824T015K1A
1.0	40TS105T004K1A	40TS105T006K1A	40TS105T010K1A	40TS105T015K1A
1.2	40TS125T004K1A	40TS125T006K1A	40TS125T010K1A	40TS125T015K1A
1.5	40TS155T004K1A	40TS155T006K1A	40TS155T010K1A	40TS155T015K1A
1.8	40TS185T004K1A	40TS185T006K1A	40TS185T010K1A	40TS185T015K1A
2.2	40TS225T004K1A	40TS225T006K1A	40TS225T010K1A	40TS225T015K1A
2.7	40TS275T004K1A	40TS275T006K1A	40TS275T010K1A	
3.3	40TS335T004K1A	40TS335T006K1A	40TS335T010K1A	
3.9	40TS395T004K1A	40TS395T006K1A		
4.7	40TS475T004K1A	40TS475T006K1A		40TS475X015K1A
5.6	40TS565T004K1A			40TS565X015K1A
6.8	40TS685T004K1A		40TS685X010K1A	40TS685X015K1A
8.2			40TS825X010K1A	40TS825X015K1A
10		40TS106X006K1A	40TS106X010K1A	40TS106X015K1A
12		40TS126X006K1A	40TS126X010K1A	40TS126X015K1A
15		40TS156X006K1A	40TS156X010K1A	40TS156X015K1A
18	40TS186X004K1A	40TS186X006K1A	40TS186X010K1A	
22	40TS226X004K1A	40TS226X006K1A		
27	40TS276X004K1A	40TS276X006K1A		
33	40TS336X004K1A			
39	40TS396X004K1A			

SERIES 40TS

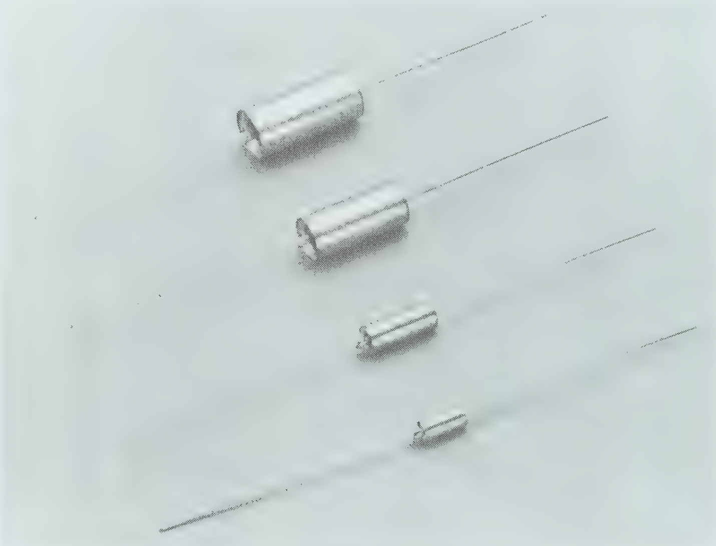
Industrial Type Tantalum Capacitors

STANDARD RATINGS

Capacitance	20 WVDC ±10% Insulated	35 WVDC ±10% Insulated	50 WVDC ±10% Insulated	75 WVDC ±10% Insulated
.0047	40TS472T020K1A	40TS472T035K1A	40TS472T050K1A	40TS472T075K1A
.0056	40TS562T020K1A	40TS562T035K1A	40TS562T050K1A	40TS562T075K1A
.0068	40TS682T020K1A	40TS682T035K1A	40TS682T050K1A	40TS682T075K1A
.0082	40TS822T020K1A	40TS822T035K1A	40TS822T050K1A	40TS822T075K1A
.010	40TS103T020K1A	40TS103T035K1A	40TS103T050K1A	40TS103T075K1A
.012	40TS123T020K1A	40TS123T035K1A	40TS123T050K1A	40TS123T075K1A
.015	40TS153T020K1A	40TS153T035K1A	40TS153T050K1A	40TS153T075K1A
.018	40TS183T020K1A	40TS183T035K1A	40TS183T050K1A	40TS183T075K1A
.022	40TS223T020K1A	40TS223T035K1A	40TS223T050K1A	40TS223T075K1A
.027	40TS273T020K1A	40TS273T035K1A	40TS273T050K1A	40TS273T075K1A
.033	40TS333T020K1A	40TS333T035K1A	40TS333T050K1A	40TS333T075K1A
.039	40TS393T020K1A	40TS393T035K1A	40TS393T050K1A	40TS393T075K1A
047	40TS473T020K1A	40TS473T035K1A	40TS473T050K1A	40TS473T075K1A
.056	40TS563T020K1A	40TS563T035K1A	40TS563T050K1A	40TS563T075K1A
.068	40TS683T020K1A	40TS683T035K1A	40TS683T050K1A	40TS683T075K1A
.082	40TS823T020K1A	40TS823T035K1A	40TS823T050K1A	40TS823T075K1A
.10	40TS104T020K1A	40TS104T035K1A	40TS104T050K1A	40TS104T075K1A
.12	40TS124T020K1A	40TS124T035K1A	40TS124T050K1A	40TS124T075K1A
.15	40TS154T020K1A	40TS154T035K1A	40TS154T050K1A	40TS154T075K1A
18	40TS184T020K1A	40TS184T035K1A	40TS184T050K1A	40TS184T075K1A
.22	40TS224T020K1A	40TS224T035K1A	40TS224T050K1A	40TS224T075K1A
.27	40TS274T020K1A	40TS274T035K1A	40TS274T050K1A	40TS274T075K1A
.33	40TS334T020K1A	40TS334T035K1A	40TS334T050K1A	40TS334T075K1A
.39	40TS394T020K1A	40TS394T035K1A	40TS394T050K1A	40TS394X075K1A
.47	40TS474T020K1A	40TS474T035K1A	40TS474T050K1A	40TS474X075K1A
.56	40TS564T020K1A	40TS564T035K1A		40TS564X075K1A
68	40TS684T020K1A	40TS684T035K1A		40TS684X075K1A
.82	40TS824T020K1A	40TS824T035K1A		40TS824X075K1A
1.0	40TS105T020K1A	40TS105T035K1A		40TS105X075K1A
1.2	40TS125T020K1A			40TS125X075K1A
1.5	40TS155T020K1A		40TS155X050K1A	40TS155X075K1A
1.8		40TS185X035K1A	40TS185X050K1A	40TS185X075K1A
2.2		40TS225X035K1A	40TS225X050K1A	
2.7		40TS275X035K1A	40TS275X050K1A	
3.3	40TS335X020K1A	40TS335X035K1A	40TS335X050K1A	
3.9	40TS395X020K1A	40TS395X035K1A	40TS395X050K1A	
4.7	40TS475X020K1A	40TS475X035K1A		
5.6	40TS565X020K1A	40TS565X035K1A		
6.8	40TS685X020K1A			
8.2	40TS825X020K1A			
10	40TS106X020K1A			
12				
15				

SERIES 40XS

Xtra-Capacitance Hermetically Sealed Solid Electrolyte Tantalum Capacitor



3 Tantalum Capacitors

DESCRIPTION

The Philips Components 40XS Series is a solid electrolyte sintered tantalum anode capacitor body, soldered into a tubular metal can and hermetically sealed with a glass-to-metal seal.

Available in four standard sizes, insulated and uninsulated, the 40XS Series is manufactured utilizing the highly automated processing and assembly techniques which Philips Components has developed for producing established reliability devices.

The 40XS Series is especially adapted for applications involving coupling, filtering, and timing in those computer, industrial, and commercial circuits requiring capacitors with more capacitance than available in standard devices.

FEATURES

- –55° TO 125°C OPERATION
- 6 THRU 60 VOLTS
- 0.82 uf THRU 1000 uf
- FOUR STANDARD SIZES
- COUPLING
- FILTERING
- TIMING

STANDARD RATINGS

CAPACITANCE +25°C 120 Hz	6 WVDC ±10% INSULATED 4V @ 125°C	10 WVDC ±10% INSULATED 7V @ 125°C	15 WVDC ±10% INSULATED 10V @ 125°C	20 WVDC ±10% INSULATED 13V @ 125°C
.82	40XS824A006K1A	40XS824A010K1A	40XS824A015K1A	40XS824A020K1A
1.0	40XS105A006K1A	40XS105A010K1A	40XS105A015K1A	40XS105A020K1A
1.2	40XS125A006K1A	40XS125A010K1A	40XS125A015K1A	40XS125A020K1A
1.5	40XS155A006K1A	40XS155A010K1A	40XS155A015K1A	40XS155A020K1A
1.8	40XS185A006K1A	40XS185A010K1A	40XS185A015K1A	40XS185A020K1A
2.2	40XS225A006K1A	40XS225A010K1A	40XS225A015K1A	40XS225A020K1A
2.7	40XS275A006K1A	40XS275A010K1A	40XS275A015K1A	40XS275A020K1A●
3.3	40XS335A006K1A	40XS335A010K1A	40XS335A015K1A	40XS335A020K1A●
3.9	40XS395A006K1A	40XS395A010K1A	40XS395A015K1A	40XS395A020K1A●
4.7	40XS475A006K1A	40XS475A010K1A	40XS475A015K1A●	40XS475B020K1A
5.6	40XS565A006K1A	40XS565A010K1A	40XS565A015K1A●	40XS565B020K1A
6.8	40XS685A006K1A	40XS685A010K1A●	40XS685B015K1A	40XS685B020K1A
8.2	40XS825A006K1A	40XS825A010K1A●	40XS825B015K1A	40XS825B020K1A
10	40XS106A006K1A●	40XS106B010K1A	40XS106B015K1A	40XS106B020K1A
12	40XS126A006K1A●	40XS126B010K1A	40XS126B015K1A	40XS126B020K1A
15	40XS156B006K1A	40XS156B010K1A	40XS156B015K1A	40XS156B020K1A
18	40XS186B006K1A	40XS186B010K1A	40XS186B015K1A	40XS186B020K1A●
22	40XS226B006K1A	40XS226B010K1A	40XS226B015K1A	40XS226B020K1A●
27	40XS276B006K1A	40XS276B010K1A	40XS276B015K1A	40XS276B020K1A●
33	40XS336B006K1A	40XS336B010K1A	40XS336B015K1A●	40XS336C020K1A
39	40XS396B006K1A	40XS396B010K1A	40XS396B015K1A●	40XS396C020K1A
47	40XS476B006K1A	40XS476B010K1A●	40XS476C015K1A	40XS476C020K1A
56	40XS566B006K1A	40XS566B010K1A●	40XS566C015K1A	40XS566C020K1A●
68	40XS686B006K1A	40XS686B010K1A●	40XS686C015K1A	40XS686C020K1A●
82	40XS826B006K1A	40XS826B010K1A●	40XS826C015K1A	40XS826C020K1A●
100	40XS107B006K1A●	40XS107C010K1A	40XS107C015K1A	40XS107C020K1A●
120	40XS127C006K1A	40XS127C010K1A	40XS127C015K1A	40XS127C020K1A●
150	40XS157C006K1A	40XS157C010K1A●	40XS157C015K1A●	40XS157D020K1A●
180	40XS187C006K1A	40XS187C010K1A	40XS187C015K1A●	40XS187D020K1A●
220	40XS227C006K1A	40XS227C010K1A●	40XS227D015K1A●	
270	40XS277C006K1A	40XS277C010K1A●	40XS277D015K1A●	
330	40XS337C006K1A●	40XS337D010K1A	40XS337D015K1A●	
390	40XS397C006K1A●	40XS397D010K1A●		
470	40XS477C006K1A●	40XS477D010K1A●		
560	40XS567D006K1A	40XS567D010K1A●		
680	40XS687D006K1A●			
820	40XS827D006K1A●			
1000	40XS108D006K1A●			

● ITEM AVAILABLE TO MIL-C-39003 STYLE CSR23

PART NUMBER SYSTEM

EXAMPLE

4 0 X S 105 A 006 K 1 A

- A — INDUSTRIAL
- 1 — 0 = UNSLEEVED, 1 = SLEEVED
- K — CAPACITANCE TOLERANCE: J = ±5% K = ±10% M = ±20%
- 006 — RATED VOLTAGE @ 85°C
- A — CASE SIZE
- 105 — CAPACITANCE IN PICOFARADS. First two digits are significant figures. Third digit number of zeros to follow. 105 = 1.0 uf, 106 = 10 uf
- S — SOLID ELECTROLYTE
- X — SERIES
- 0 — AXIAL LEAD
- 4 — TANTALUM CAPACITOR

SERIES 40XS

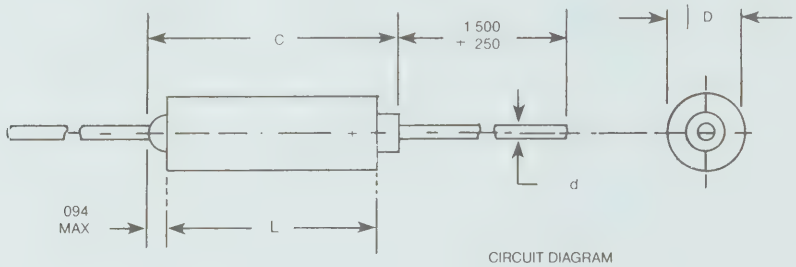
Industrial Type Tantalum Capacitors

3

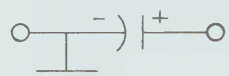
Tantalum Capacitors

STANDARD RATINGS

CAPACITANCE +25°C 120 Hz	30 WVDC ±10% INSULATED 20V @ 125°C	35 WVDC ±10% INSULATED 23V @ 125°C	50 WVDC ±10% INSULATED 33V @ 125°C	60 WVDC ±10% INSULATED 40V @ 125°C
.82	40XS824A030K1A	40XS824A035K1A	40XS824A050K1A	40XS824A060K1A
1.0	40XS105A030K1A	40XS105A035K1A	40XS105A050K1A	40XS105A060K1A
1.2	40XS125A030K1A	40XS125A035K1A	40XS125A050K1A●	40XS125B060K1A
1.5	40XS155A030K1A	40XS155A035K1A	40XS155A050K1A●	40XS155B060K1A
1.8	40XS185A030K1A	40XS185A035K1A●	40XS185B050K1A	40XS185B060K1A
2.2	40XS225A030K1A	40XS225B035K1A	40XS225B050K1A	40XS225B060K1A
2.7	40XS275A030K1A	40XS275B035K1A	40XS275B050K1A	40XS275B060K1A
3.3	40XS335B030K1A	40XS335B035K1A	40XS335B050K1A	40XS335B060K1A
3.9	40XS395B030K1A	40XS395B035K1A	40XS395B050K1A	40XS395B060K1A
4.7	40XS475B030K1A	40XS475B035K1A	40XS475B050K1A	40XS475B060K1A
5 6	40XS565B030K1A	40XS565B035K1A	40XS565B050K1A●	40XS565B060K1A
6 8	40XS685B030K1A	40XS685B035K1A	40XS685B050K1A●	40XS685C060K1A
8.2	40XS825B030K1A	40XS825B035K1A●	40XS825C050K1A	40XS825C060K1A
10	40XS106B030K1A	40XS106B035K1A●	40XS106C050K1A	40XS106C060K1A
12	40XS126B030K1A	40XS126C035K1A	40XS126C050K1A	40XS126C060K1A
15	40XS156B030K1A	40XS156C035K1A	40XS156C050K1A	40XS156C060K1A
18	40XS186B030K1A	40XS186C035K1A	40XS186C050K1A	40XS186C060K1A
22	40XS226C030K1A	40XS226C035K1A	40XS226C050K1A●	40XS226C060K1A
27	40XS276C030K1A	40XS276C035K1A	40XS276C050K1A●	40XS276D060K1A
33	40XS336C030K1A	40XS336C035K1A●	40XS336D050K1A●	40XS336D060K1A
39	40XS396C030K1A	40XS396C035K1A●	40XS396D050K1A●	
47	40XS476C030K1A	40XS476C035K1A●		
56	40XS566C030K1A	40XS566D035K1A●		
68	40XS686C030K1A	40XS686D035K1A●		
82	40XS826D030K1A			
100	40XS107D030K1A			



CIRCUIT DIAGRAM



DIMENSIONS — INCHES (mm)								
	Uninsulated		Insulated					
Case Size	D +.016 (0.41) −.015 (0.38)	L ±.031 (.079)	D +.016 (0.41) −.015 (0.38)	L ±.031	C Max.	d Lead Dia. d ±002 (0.05)	Lead Length l ±.25 (±6.40)	Approx. Weight Grams
A	0.125 (3.18)	0.250 (635)	0.135 (3.43)	0.286 (7.26)	.422 (10.72)	0.020 (0.51)	1.50	0.7
B	0.175 (4.45)	0.438 (11.12)	0.185 (4.70)	0.474 (12.04)	.610 (15.49)	0.020 (0.51)	1.50	1.6
C	0.279 (7.10)	0.650 (16.50)	0.289 (7.34)	0.686 (17.42)	.822 (20.88)	0.025 (0.64)	1.50	4.9
D	0.341 (8.65)	0.750 (19.05)	0.351 (8.92)	0.786 (19.96)	.922 (23.42)	0.025 (0.64)	1.50	8.8

SERIES 40XS
Industrial Type Tantalum Capacitors

DESIGN AND CONSTRUCTION
Each 40XS type capacitor consists of a highly purified sintered tantalum anode body, utilizing an electrolytically formed oxide dielectric and a solid electrolyte, soldered in a metal case with axial leads and hermetically sealed.

INSULATION — When specified, a MYLAR* sleeve will be placed over the metal can. The insulation will not soften or creep over the operating temperature range.

RADIAL CONFIGURATION — When radial lead configuration is desired, the negative lead can be bent down the side of the metal can.

LEADS — Lead material is Grade A nickel, tin lead plated to facilitate soldering. Other lead material available on request.

MARKING—Capacitance will be marked with Philips Components part marking capacitance, voltage, and a + sign for polarity as a minimum. When space permits, capacitance tolerance and date code will be added.

DC WORKING VOLTAGE
40XS Series capacitors are available in 8 voltage ratings applicable from -55°C to 85°C without derating, and to 125°C with ⅔ linear derating, (see chart under para. 3).

SURGE VOLTAGE
The surge voltage is the maximum DC voltage, including peak AC or other pulses, which may be applied for short duration.

In no case shall the sum of AC voltage and applied DC working voltage exceed the working voltage of the capacitor. The surge voltages are as follows:

Rated WVDC up to 85°C	Derated 125°C	SURGE VOLTAGE 85°C	SURGE VOLTAGE 125°C
6	4	8	5
10	7	13	9
15	10	20	12
20	13	26	16
30	20	40	27
35	23	46	28
50	33	65	40
60	40	80	54

CAPACITANCE
Capacitance shall be measured on a polarized bridge, at or referred to 120 cps at 25°C. The maximum DC bias shall be 2.2 VDC for all A.C. measurements. The magnitude of the A.C. signal shall be limited to 1.0 VRMS.

The capacitance so determined shall be within specified initial capacitance tolerance.

TOLERANCE — The 40XS Series is available in ±20%, ±10% and ±5% capacitance tolerances.

DISSIPATION FACTOR
DF shall be measured on a polarized bridge, at or referred to 120 cps at 25°C. The maximum DC bias shall be 2.2 VDC for all AC measurements. The magnitude of the AC signal shall be limited to 1.0 VRMS.

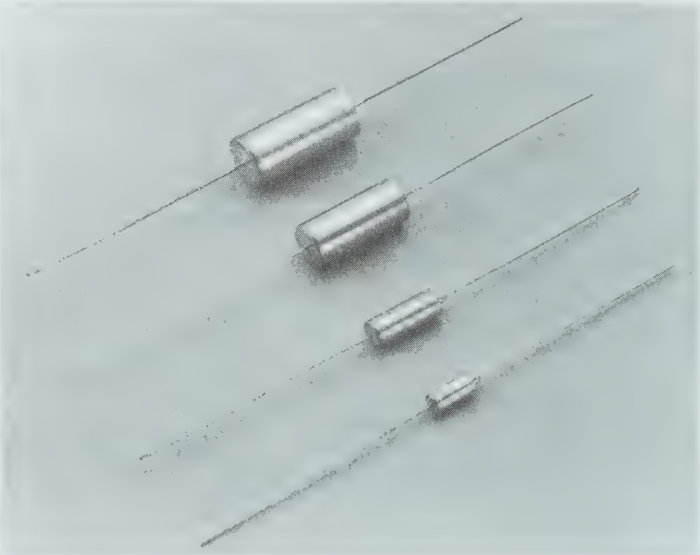
The DF so determined shall not exceed:

0.01 uf to 56 uf	6% DF maximum
68 uf to 120 uf	8% DF maximum
150 uf and Up	10% DF maximum

D.C. LEAKAGE CURRENT
DCL shall not exceed 0.02 uA/ufV, but need not be less than 1uA when determined with a 1000 ohm current limiting resistor in series with the test capacitor after a 5 minute application of rated voltage at 25°C. The DCL at 85° shall not exceed 10 times the 25°C limits. At 125°C the DCL shall not exceed 12 times the 25°C limits.

SERIES 40YS

Xtra-Capacitance Hermetically Sealed Solid Electrolyte Tantalum Capacitor



3

Tantalum Capacitors

DESCRIPTION

The Philips Components 40YS Series is a solid electrolyte sintered tantalum anode capacitor body, soldered into a tubular metal can and hermetically sealed with a glass-to-metal seal.

Available in four standard sizes, insulated and uninsulated, the 40YS Series is manufactured utilizing the highly automated processing and assembly techniques which Philips Components has developed for producing established reliability devices.

The 40YS Series is especially adapted for applications involving coupling, filtering, and timing in those computer, industrial, and commercial circuits requiring capacitors with more capacitance than available in standard devices.

FEATURES

- −55° TO 125°C OPERATION
- 6 THRU 60 VOLTS
- 1.0 uf THRU 1000 uf
- FOUR STANDARD SIZES
- COUPLING
- FILTERING LOW IMPEDANCE
- TIMING

SERIES 40YS

Industrial Type Tantalum Capacitors

STANDARD RATINGS

CAPACITANCE +25°C 120 Hz	6 WVDC ±10% INSULATED 4V @ 125°C	10 WVDC ±10% INSULATED 7V @ 125°C	15 WVDC ±10% INSULATED 10V @ 125°C	20 WVDC ±10% INSULATED 13V @ 125°C
1.0	40YS105A006K1A	40YS105A010K1A	40YS105A015K1A	40YS105A020K1A
1.2	40YS125A006K1A	40YS125A010K1A	40YS125A015K1A	40YS125A020K1A
1.5	40YS155A006K1A	40YS155A010K1A	40YS155A015K1A	40YS155A020K1A
1.8	40YS185A006K1A	40YS185A010K1A	40YS185A015K1A	40YS185A020K1A
2.2	40YS225A006K1A	40YS225A010K1A	40YS225A015K1A	40YS225A020K1A
2.7	40YS275A006K1A	40YS275A010K1A	40YS275A015K1A	40YS275A020K1A•
3.3	40YS335A006K1A	40YS335A010K1A	40YS335A015K1A	40YS335A020K1A•
3.9	40YS395A006K1A	40YS395A010K1A	40YS395A015K1A	40YS395A020K1A•
4.7	40YS475A006K1A	40YS475A010K1A	40YS475A015K1A•	40YS475B020K1A
5.6	40YS565A006K1A	40YS565A010K1A	40YS565A015K1A•	40YS565B020K1A
6.8	40YS685A006K1A	40YS685A010K1A•	40YS685B015K1A	40YS685B020K1A
8.2	40YS825A006K1A	40YS825A010K1A•	40YS825B015K1A	40YS825B020K1A
10	40YS106A006K1A•	40YS106B010K1A	40YS106B015K1A	40YS106B020K1A
12	40YS126A006K1A•	40YS125B010K1A	40YS126B015K1A	40YS126B020K1A
15	40YS156B006K1A	40YS156B010K1A	40YS156B015K1A	40YS156B020K1A
18	40YS186B006K1A	40YS186B010K1A	40YS186B015K1A	40YS186B020K1A•
22	40YS226B006K1A	40YS226B010K1A	40YS226B015K1A	40YS226B020K1A•
27	40YS276B006K1A	40YS276B010K1A	40YS276B015K1A	40YS276B020K1A•
33	40YS336B006K1A	40YS336B010K1A	40YS336B015K1A	40YS336C020K1A
39	40YS396B006K1A	40YS396B010K1A	40YS396B015K1A•	40YS396C020K1A
47	40YS576B006K1A	40YS476B010K1A•	40YS476C015K1A	40YS476C020K1A
56	40YS566B006K1A	40YS566B010K1A•	40YS566C015K1A	40YS566C020K1A•
68	40YS686B006K1A	40YS686B010K1A•	40YS686C015K1A	40YS686C020K1A•
82	40YS826B006K1A	40YS826B010K1A•	40YS826C015K1A	40YS826C020K1A•
100	40YS107B006K1A•	40YS107C010K1A	40YS107C015K1A	40YS107C020K1A•
120	40YS127C006K1A	40YS127C010K1A	40YS127C015K1A	40YS127C020K1A•
150	40YS157C006K1A	40YS157C010K1A•	40YS157C015K1A•	40YS157D020K1A•
180	40YS187C006K1A	40YS187C010K1A	40YS187C015K1A•	40YS187D020K1A•
220	40YS227C006K1A	40YS227C010K1A•	40YS227D015K1A•	
270	40YS277C006K1A	40YS277C010K1A•	40YS277D015K1A•	
330	40YS337C006K1A•	40YS337D010K1A	40YS337D015K1A•	
390	40YS397C006K1A•	40YS397D010K1A•		
470	40YS477C006K1A•	40YS477D010K1A•		
560	40YS567D006K1A	40YS567D010K1A•		
680	40YS687D006K1A•			
820	40YS827D006K1A•			
1000	40YS108D006K1A•			

*Item available to MIL-C-39003 style CSR33

PART NUMBER SYSTEM

EXAMPLE

4 0 Y S 105 A 006 K 1 A

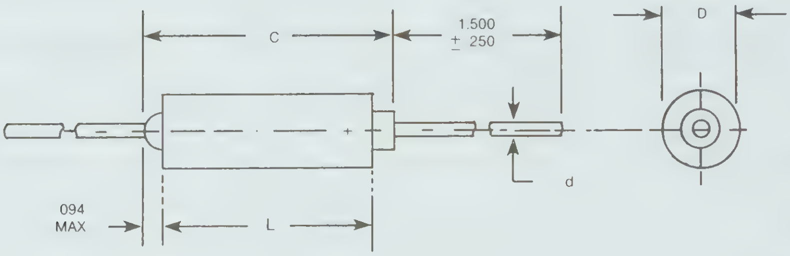
- A — INDUSTRIAL
- 1 — 0 = UNSLEEVED, 1 = SLEEVED
- K — CAPACITANCE TOLERANCE: J = ±5% K = ±10% M = ±20%
- 006 — RATED VOLTAGE @ 85°C
- A — CASE SIZE
- 105 — CAPACITANCE IN PICOFARADS. First two digits are significant figures. Third digit number of zeros to follow. 105 = 1.0 uF, 106 = 10 uF
- S — SOLID ELECTROLYTE
- Y — SERIES
- 0 — AXIAL LEAD
- 4 — TANTALUM CAPACITOR

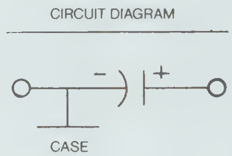
SERIES 40YS

Industrial Type Tantalum Capacitors

STANDARD RATINGS

CAPACITANCE +25°C 120 Hz	30 WVDC ±10% INSULATED 20V @ 125°C	35 WVDC ±10% INSULATED 23V @ 125°C	50 WVDC ±10% INSULATED 33V @ 125°C	60 WVDC ±10% INSULATED 40V @ 125°C
1.0	40YS105A030K1A	40YS105A035K1A	40YS105A050K1A	40YS105A060K1A
1.2	40YS125A030K1A	40YS125A035K1A	40YS125A050K1A•	40YS125B060K1A
1.5	40YS155A030K1A	40YS155A035K1A	40YS155A050K1A•	40YS155B060K1A
1.8	40YS185A030K1A	40YS185A035K1A•	40YS185B050K1A	40YS185B060K1A
2.2	40YS225A030K1A	40YS225B035K1A	40YS225B050K1A	40YS225B060K1A
2.7	40YS275A030K1A	40YS275B035K1A	40YS275B050K1A	40YS275B060K1A
3.3	40YS335B030K1A	40YS335B035K1A	40YS335B050K1A	40YS335B060K1A
3.9	40YS395B030K1A	40YS395B035K1A	40YS395B050K1A	40YS395B060K1A
4.7	40YS475B030K1A	40YS475B035K1A	40YS475B050K1A	40YS475B060K1A
5.6	40YS565B030K1A	40YS565B035K1A	40YS565B050K1A•	40YS565B060K1A
6.8	40YS685B030K1A	40YS685B035K1A	40YS685B050K1A•	40YS685C060K1A
8.2	40YS825B030K1A	40YS825B035K1A•	40YS825C050K1A	40YS825C060K1A
10	40YS106B030K1A	40YS106B035K1A•	40YS106C050K1A	40YS106C060K1A
12	40YS126B030K1A	40YS126C035K1A	40YS126C050K1A	40YS126C060K1A
15	40YS156B030K1A	40YS156C035K1A	40YS156C050K1A	40YS156C060K1A
18	40YS186B030K1A	40YS186C035K1A	40YS186C050K1A	40YS186C060K1A
22	40YS226C030K1A	40YS226C035K1A	40YS226C050K1A•	40YS226C060K1A
27	40YS276C030K1A	40YS276C035K1A	40YS276C050K1A•	40YS276D060K1A
33	40YS336C030K1A	40YS336C035K1A•	40YS336D050K1A•	40YS336D060K1A
39	40YS396C030K1A	40YS396C035K1A•	40YS396D050K1A•	
47	40YS476C030K1A	40YS476C035K1A•		
56	40YS566C030K1A	40YS566D035K1A•		
68	40YS686C030K1A	40YS686D035K1A•		
82	40YS826D030K1A			
100	40YS107D030K1A			





DIMENSIONS — INCHES (mm)								
	Uninsulated		Insulated					
Case Size	D +.016 (0.41) −.015 (0.38)	L ±.031 (.079)	D +.016 (0.41) −.015 (0.38)	L ±.031	C Max.	d Lead Dia. d ±002 (0.05)	Lead Length l ±.25 (±6.40)	Approx. Weight Grams
A	0.125 (3.18)	0.250 (635)	0.135 (3.43)	0.286 (7.26)	.422 (10.72)	0.020 (0.51)	1.50	0.7
B	0.175 (4.45)	0.438 (11.12)	0.185 (4.70)	0.474 (12.04)	.610 (15.49)	0.020 (0.51)	1.50	1.6
C	0.279 (7.10)	0.650 (16.50)	0.289 (7.34)	0.686 (17.42)	.822 (20.88)	0.025 (0.64)	1.50	4.9
D	0.341 (8.65)	0.750 (19.05)	0.351 (8.92)	0.786 (19.96)	.922 (23.42)	0.025 (0.64)	1.50	8.8

SERIES 40YS
Industrial Type Tantalum Capacitors

1. DESIGN AND CONSTRUCTION
Each 40YS type capacitor consists of a highly purified sintered tantalum anode body, utilizing an electrolytically formed oxide dielectric and a solid electrolyte, soldered in a metal case with axial leads and hermetically sealed.

INSULATION — When specified, a MYLAR* sleeve will be placed over the metal can. The insulation will not soften or creep over the operating temperature range.

RADIAL CONFIGURATION – When radial lead configuration is desired, the negative lead can be bent down the side of the metal can.

LEADS – Lead material is Grade A nickel, tin lead plated to facilitate soldering. Other lead material available on request.

MARKING—Capacitance will be marked with Philips Components part marking capacitance, voltage, and a + sign for polarity as a minimum. When space permits, capacitance tolerance and date code will be added.

2. DC WORKING VOLTAGE
40YS Series capacitors are available in 8 voltage ratings applicable from −55°C to 85°C without derating, and to 125°C with ⅔ linear derating, (see chart under para. 3).

3. SURGE VOLTAGE
The surge voltage is the maximum DC voltage, including peak AC or other pulses, which may be applied for short duration.
In no case shall the sum of AC voltage and applied DC working voltage exceed the working voltage of the capacitor. The surge voltages are as follows:

Rated WVDC up to 85°C	Derated 125°C	SURGE VOLTAGE 85°C	SURGE VOLTAGE 125°C
6	4	8	5
10	7	13	9
15	10	20	12
20	13	26	16
30	20	40	27
35	23	46	28
50	33	65	40
60	40	80	54

4. CAPACITANCE
Capacitance shall be measured on a polarized bridge, at or referred to 120 cps at 25°C. The maximum DC bias shall be 2.2 VDC for all A.C. measurements. The magnitude of the A.C. signal shall be limited to 1.0 VRMS.

The capacitance so determined shall be within specified initial ±5% capacitance tolerances.

TOLERANCE – The 40YS Series is available in ±20%, ±10% and ±5% capacitance tolerances.

5. DISSIPATION FACTOR
DF shall be measured on a polarized bridge, at or referred to 120 cps at 25°C. The maximum DC bias shall be 2.2 VDC for all AC measurements. The magnitude of the AC signal shall be limited to 1.0 VRMS.
The DF so determined shall not exceed:

0.01 uf to 56 uf	6% DF maximum
68 uf to 120 uf	8% DF maximum
150 uf and Up	10% DF maximum

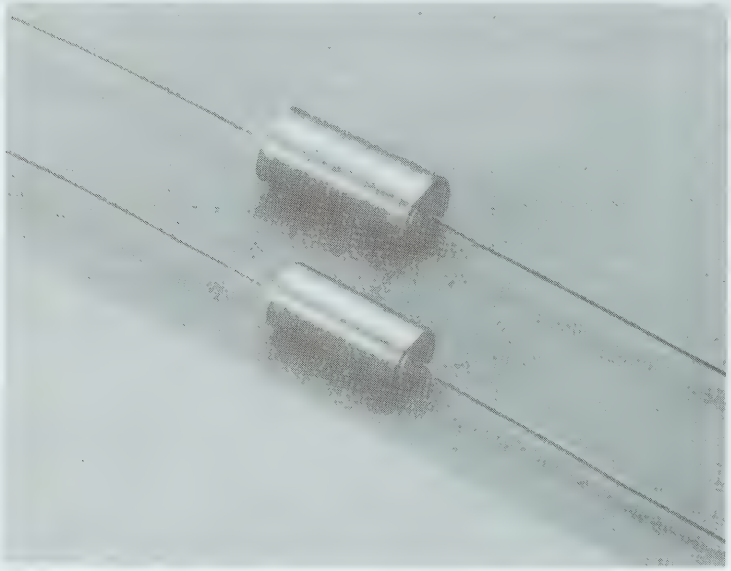
6. D.C. LEAKAGE CURRENT
DCL shall not exceed .02 uA/ufV, but need not be less than 1uA when determined with a 1000 ohm current limiting resistor in series with the test capacitor after a 5 minute application of rated voltage at 25°C. The DCL at 85° shall not exceed 10 times the 25°C limits. At 125°C the DCL shall not exceed 12 times the 25°C limits.

7. SURGE CURRENT
Test as specified in MIL-C-39003/6.

*TM-DuPont Company

SERIES 40ZS

High Frequency Solid Tantalum Capacitor



DESCRIPTION

Philips Components type 40ZS capacitor is a fixed solid electrolyte tantalum type with hermetic seal. This construction provides an inherently long life and very stable electric characteristics in a temperature range of −55 through +125°C. This capacitor provides low impedence to ripple current at frequencies above 1KHz through 100KHz. At these frequencies, the 40ZS also provides lower equivalent series resistance (ESR) than conventional type solid tantalum capacitors. Lower ESR means lower power loss which results in cost, space and weight savings.

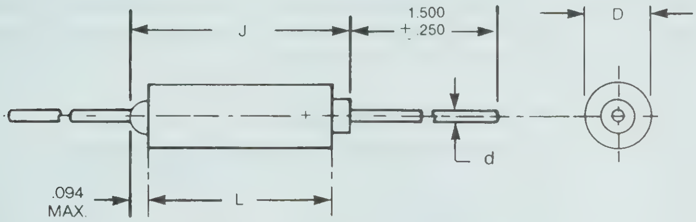
FEATURES

- High Ripple Current
- Low ESR
- Low Impedence at High Frequency
- Small Size
- Extremely Stable Capacitance
- Hermetic Seal
- Long Life
- CSR 21 Style

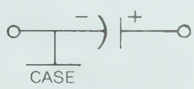
SERIES 40ZS

Industrial Type Tantalum Capacitors

OUTLINE DRAWING AND DIMENSIONS



CIRCUIT DIAGRAM



DIMENSIONS—INCHES (mm)								
	Uninsulated		Insulated					
Case Size	D +.016 (0.41) −.015 (0.38)	L±.031 (.079)	D+.016 (0.41) −.015 (0.38)	L±.031	J Max.	d Lead Dia. d±002 (0.05)	Lead Length l±.25 (±6.40)	Approx. Weight Grams
C	0.279 (7.10)	0.650 (16.50)	0.289 (7.34)	0.686 (17.42)	.822 (20.88)	0.025 (0.64)	1.50	4.9
D	0.341 (8.65)	0.750 (19.05)	0.351 (8.92)	0.786 (19.96)	.922 (23.42)	0.025 (0.64)	1.50	8.8

NOTES:

1. The case insulation shall extend .015'' (0.38mm) minimum beyond each end. However, when a shrink-fitted insulation is used, it shall lap over the ends of the capacitor body.
2. Lead length may be a minimum of 1-inch long for use in tape and reel automatic insertion equipment, when specified
3. Insulation thickness is included in dimension D.

STANDARD RATINGS

CAPACITANCE −55°C +125°C	6WVDC ±.10% INSULATED	10 WVDC ±.10% INSULATED	15 WVDC ±.10% INSULATED	20WVDC ±.10% INSULATED	35 WVDC ±.10% INSULATED	50 WVDC ±.10% INSULATED
5.6				—	—	40ZS565C050K1A
6.8				—	—	40ZS685C050K1A
8.2				—	—	40ZS825C050K1A
10				—	—	40ZS106C050K1A
12				—	—	40ZS126C050K1A
15				—	—	40ZS156C050K1A
18				—	—	40ZS186C050K1A
22				—	40ZS226C035K1A	40ZS226D050K1A
27				40ZS276C020K1A	40ZS276D035K1A	
33				40ZS336C020K1A	40ZS336D035K1A	
39				40ZS396C020K1A	40ZS396D035K1A	
47				40ZS476C020K1A	40ZS476D035K1A	
56	—	—	40ZS566C015K1A	40ZS566D020K1A		
68	—	—	40ZS686C015K1A	40ZS686D020K1A		
82	—	40ZS826C010K1A	—	40ZS826D020K1A		
100	—	40ZS107C010K1A	—	40ZS107D020K1A		
120	—	40ZS127C010K1A	40ZS127D015K1A			
150	40ZS157C006K1A	—	40ZS157D015K1A			
180	40ZS187C006K1A	40ZS187D010K1A	—			
220	—	40ZS227D010K1A	—			
270	40ZS277D006K1A	—	—			
330	40ZS337D006K1A	—	—			

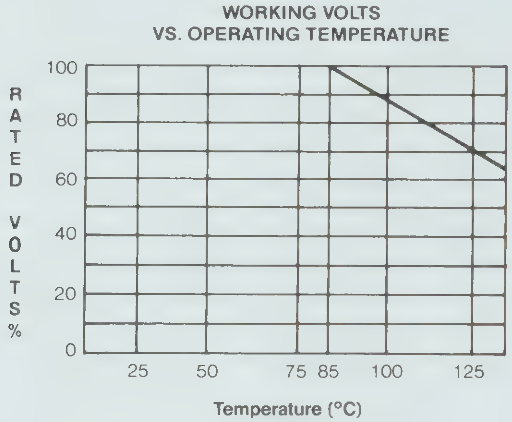
SERIES 40ZS

Industrial Type Tantalum Capacitors

ELECTRICAL DATA

1. DC Working Voltage

Philips Components type 40ZS is designed to operate reliably at voltages from −55°C to 125°C. This capacitor is offered in six different voltages: six through fifty volts.



2. Surge Voltage and Voltage Derating

Surge voltage is the maximum amount of voltage which may be applied to the capacitor. 85°C and 125°C surge voltages and voltage derating with temperature are shown below.

Working Voltage WVDC 85°C	Derated VDC 125°C	Surge VDC	
		85°C	125°C
6	4	8	5
10	7	13	9
15	10	20	12
20	13	26	16
35	23	46	28
50	33	65	40

3. Capacitance-Effective Series

The 40ZS capacitors are measured on a polarized capacitance bridge. The capacitance is measured at 25°C and at 1 KHz. No more than two volts A.C. shall be applied and accuracy of the bridge will be within 2%.

4. Capacitance Tolerance

The 40ZS is available in 20%(M), 10%(K), 5%(J).

5. DC Leakage Current

DC leakage measurements will be taken after a five minute period of electrification, with rated DC voltage applied.

The voltage will be applied with a 1000 Ohm, ± 50 Ohm, resistor connected in series with the capacitor.

The Maximum allowable DC leakage limit at 85°C will be 10 times the maximum specified 25°C DC leakage limit.

6. Capacitance Change with Temperature

The maximum change is:

Temperature °C	Maximum Change In Capacitance
−55	−10
+85	+8
+125	+12

7. Moisture Resistance

The Philips Components series capacitors will meet the moisture resistance requirements of MIL-STD 202D, method 106. Within 6 hours of the completion of the test, the capacitance will not change more than +5% from the initial value. The DF will not exceed the requirements.

HOW TO SPECIFY

PART NUMBER SYSTEM EXAMPLE

4 0 Z S 157 C 006 K 1 A

- A — Industrial
- 1 — 0 = Unsleeved 1 = Sleeved
- K — Capacitance Tolerance M=20%, K=10%, J=5%
- 006 — Voltage Rating
- C — Case Size
- 157 — Capacitance in Picofarads
  First two digits are significant
  Third Digit number of zeros to follow:
  157=150μF
  156=15 μF
- S — Solid Tantalum
- Z — Series
- 0 — Axial Lead
- 4 — Tantalum Capacitor

ADDITIONAL APPLICATION INFORMATION

WET TANTALUM CAPACITORS

STYLES: CL64, CL65 (40LW) CLR65 (40SW)

Use: These capacitors are limited to low voltage applications. Their primary use is in low voltage power supply filtering circuits. Their low leakage current (lowest of all the tantalum types) is not appreciable below +85°C and, at ordinary operating temperatures, is comparable to good quality paper capacitors, yet they are much smaller in size. Style CLR65 capacitors are for dc applications only - no reverse voltage can be tolerated. (The most common failure mode, electrolyte leakage due to seal failure, is primarily due to the application of reverse voltage.)

Construction: These capacitors consist of a sintered-slug, acting as the anode, which is electrochemically treated to form a layer of tantalum oxide dielectric.

Physical size comparison:

With paper capacitors. These capacitors may utilize only 15 percent of the area normally required by a paper capacitor of the same capacitance value.

With aluminum electrolytic capacitors. The larger the dielectric constant the larger the capacitance which can be realized in a given space, thus a size advantage can be realized since the dielectric constant of tantalum oxide film is approximately 24 as compared to 8 for an aluminum oxide. Because of differences in foil and paper-thickness requirements, the actual size ratio will vary with different capacitances and voltage ratings and may be much more than 2:1 in favor of the tantalum capacitor.

Voltage ratings: The maximum dc rated voltages for these styles range from 6V to 125V.

Operating temperature range (with full rated voltage applied). These capacitors are suitable for operation over a temperature range of -55°C to +85°C without derating. These capacitors may be operated up to +125°C when properly derated, see figure -1.

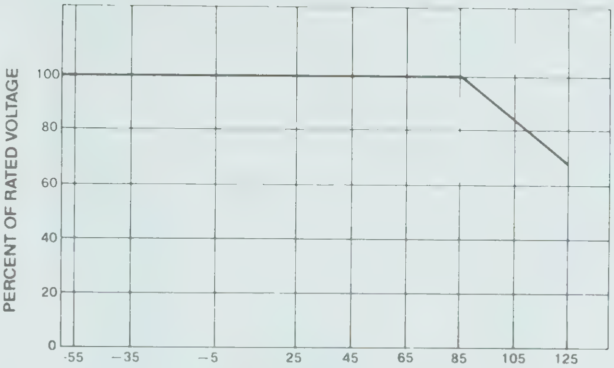


FIGURE -1. Voltage derating with temperature.

Series and parallel applications.

Series operation. Whenever tantalum capacitors are connected in series for higher voltage operation, a resistor should be paralleled across each unit. Unless a shunt resistor is used, the dc rated voltage can easily be exceeded on the capacitor in the series network with the lowest dc leakage current. To prevent capacitor destruction, a resistance value not exceeding a certain maximum should be used; this value will depend on capacitance, average dc leakage, and capacitor construction. For example: For style CLR65, size T1 units will require a maximum resistance, in megohms, equal to 3.4 divided by the square root of the capacitance (in μF); size T2, $5.2/\sqrt{C}$; size T3, $6.5/\sqrt{C}$; and size T4, $7.5/\sqrt{C}$.

Parallel operation. To obtain a higher capacitance than can be obtained from a single capacitor, a number of units may be connected in parallel. However, the sum of the peak ripple and the applied dc voltage should not exceed the dc rated voltage. The connecting leads of the parallel network should be large enough to carry the combined currents without reducing the effective capacitance due to series lead resistance.

WET TANTALUM CAPACITORS

Stability and life. Tantalum electrolytic capacitors have excellent life and shelf life characteristics. Life, at higher temperatures than with aluminum electrolytics, will show a comparatively lower decrease in capacitance. With rated voltage applied, more than 10,000 hours of life can be expected at +85°C. All styles may be expected to operate at least 2,000 hours at +85°C with less than 10 percent loss of capacitance.

Because the more stable tantalum oxide film is less subject to dissolving the surrounding electrolyte than the film in an aluminum capacitor, the shelf life of the tantalum unit is much longer, and less re-forming is required. After storage for long periods, the re-forming current is low and the time is comparatively short; it may be expected to take less than 10 minutes. These properties are affected by the storage temperature to a significant degree, being excellent at temperatures from −55°C to +25°C; good at +65°C; and relatively poor at +85°C.

NOTE: The predominant mode of failure of the wet electrolytic tantalum capacitors will most probably be a "hidden" failure mode of high or erratic leakage current which could result in a catastrophic short-circuit. This is a result of electrolyte migration past the inner seal and touching the cathodic case or ground.

Reverse Voltage. Wet slug capacitors are not suitable for applications involving any voltage reversal. They cannot be operated on unbiased ac voltage or applied in nonpolar applications involving back-to-back connections. Any ac ripple applied to wet slug capacitors must be superimposed on sufficient dc bias voltage to prevent voltage reversal. Ripple current is limited to small values because progressive degradation of the unit will result if the cathode (silver case) becomes positive during the discharge cycle.

Max. Ripple Voltage/Current. Figure 2 indicates the maximum allowable rms voltage or current for sintered-slug type capacitors at +25°C and 60 Hz.

To determine ac capability at some other frequency, multiply the voltage or current values obtained from figure 2 by a correction value from figure 3.

To determine ac capability at some other temperature, multiply the voltage or current value from figure 2 or 3, if applicable, by a correction value from figure 4.

Complex wave-shapes. When complex ripple wave-shapes are involved, they should be measured on an oscilloscope or by some other method which will give the peak rating. These capacitors should be limited to operation at ripple frequencies between 60 and 10,000 Hz (above 10,000 Hz, effective capacitance rapidly drops off). At frequencies of only a few hundred kHz, these tantalum units act as practically pure resistance.

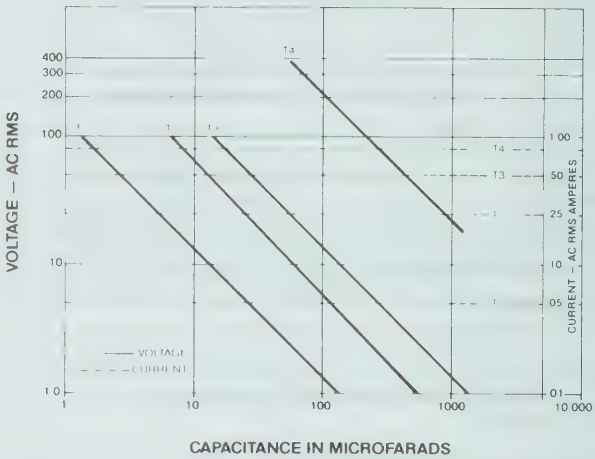


FIGURE 2. Maximum allowable ripple voltage/current vs capacitance

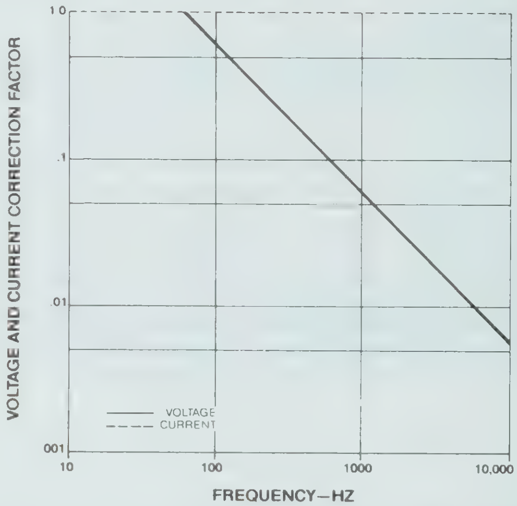


FIGURE 3. Correction factor for maximum allowable ripple voltage/current vs frequency.

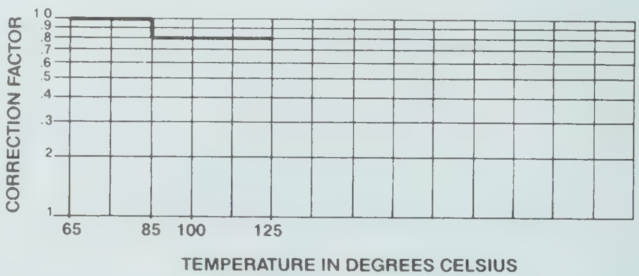


FIGURE 4. Correction factor for maximum allowable ripple voltage vs temperature

ADDITIONAL APPLICATION INFORMATION

WET TANTALUM CAPACITORS

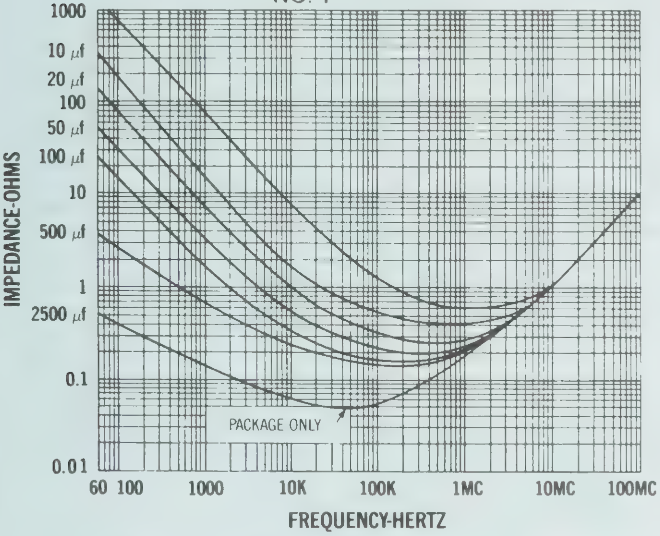
STYLE CLR 79 (40AW)

TYPICAL CURVES

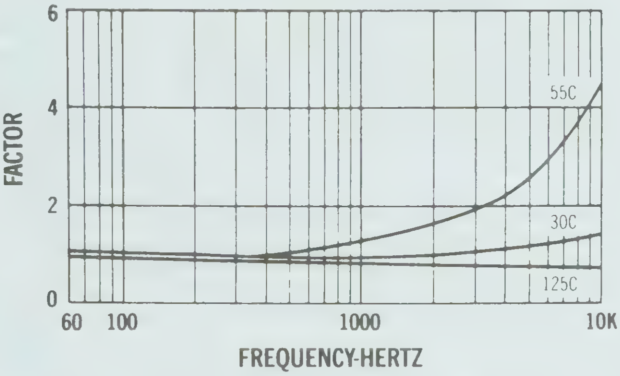
Impedance
A. Impedance in ohms at 25°C may be read directly from Curve 1.

B. To obtain impedance at temperatures other than 25°C, multiply the impedance from Curve 1 by a correction factor from Curve 2, 3 or 4.

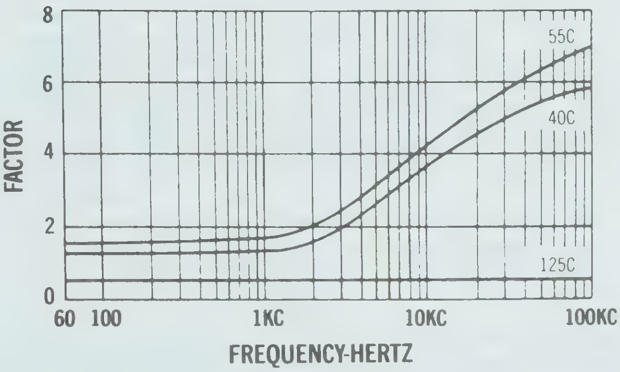
IMPEDANCE FOR TANTALUM WET SLUGS
AT 25°C
NO. 1



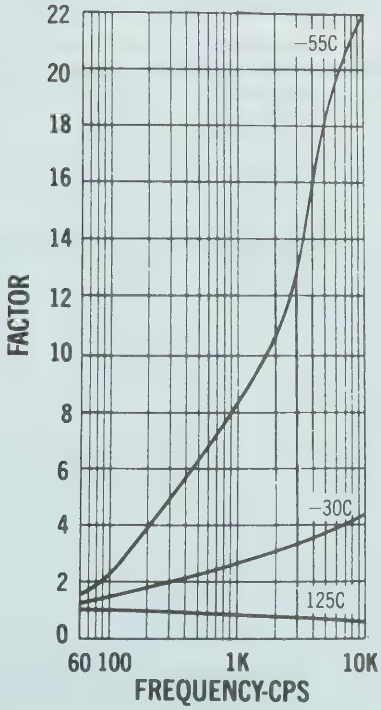
WET SLUG IMPEDANCE CORRECTION FACTORS
UP TO 5 μf
NO. 2



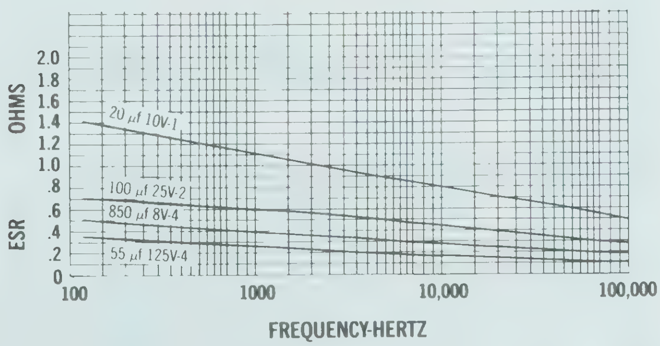
WET SLUG IMPEDANCE CORRECTION FACTORS
FOR CAPACITANCE 5-100 μf
NO. 3



WET SLUG IMPEDANCE CORRECTION FACTORS
FOR CAPACITANCE 100 μf
AND ABOVE INCLUDING PACKAGES
NO. 4



TYPICAL ESR VS. FREQUENCY AT 25°C



ADDITIONAL APPLICATION INFORMATION

SOLID TANTALUM CAPACITORS

STYLES CS12, CS13 (40SS)
CSR13 (40SS)
CSR91 (40NS)

3

Tantalum Capacitors

APPLICATION INFORMATION

Use. These capacitors are intended for use in equipment where a known order of reliability is required. These electrolytic capacitors are the most stable and most reliable electrolytic available, having a longer life characteristic than any of the other electrolytic capacitors. Because of their passive electrolyte being solid and dry, these capacitors are not temperature-sensitive; they have a lower capacitance temperature characteristic than any of the other electrolytic capacitors. Their limitations are the relatively high leakage current, limited voltage range available (6 to 100 volts), and a maximum allowable reverse voltage of 15 percent of the rated dc voltage at +25°C to 1 percent at +125°C. These capacitors are generally used where low-frequency pulsating dc components are to be bypassed or filtered out and for other uses in electronic equipment where large capacitance values are required, where space is at a premium, and where there are significant quantities of shock and vibration. These capacitors are mainly designed for filter, bypass, coupling, blocking, energy storage, and other low voltage dc applications (such as transistor circuits in missile, computer, and aircraft electronic equipment) where stability, size, weight, and shelf life are important factors. When designing transistor, timing, phaseshifting, and vacuum-tube grid circuits, the dissipation factor and power factor should be taken into consideration. For bypassing resistors, a ratio of bias resistance to capacitive reactance of 10 to 1 is usually allowed. Ratios up to 20 to 1 may be used in high-fidelity amplifier work or where space and economical considerations permit. In circuits where linear amplification is required, the amount of capacitive reactance shunting a cathode resistor will depend on the percentage of degenerative feedback desired.

These capacitors are available as polarized and nonpolarized types. Polarized types should have their cases at the same potential as the negative lead; they should be used only in dc circuits with polarity observed. Nonpolarized types should be used where reversal of potential occurs.

Construction. A porous tantalum pellet or wire serves as the anode of a solid tantalum capacitor. The surfaces of the anode are electrochemically converted to an oxide of tantalum which serves as the dielectric. These surfaces are coated with an oxide semiconductor which is the working electrolyte in solid form. This oxide semiconductor establishes contact with all of the complex surfaces of the anodized pellet and is capable of healing imperfections of the tantalum oxide dielectric film.

NOTE: In high impedance circuits, momentary breakdowns (if present) will self-heal; however, in low impedance circuits, their self-healing characteristics under momentary breakdown of the dielectric film will be nonexistent. The large currents in low impedance circuits will cause permanent damage to the capacitor. Experience has shown that a circuit resistance of 3Ω per volt is desirable to limit possible surge damage to the dielectric.

Reverse voltage. These capacitors are capable of withstanding peak voltages in the reverse direction equal to 15 percent of their dc rating at +25°C; 10 percent at +55°C; 5 percent at +85°C; and 1 percent at +125°C.

Capacitance. The tolerance on nominal capacitance at 100Hz is ±20% and ±10% (±5% on request).

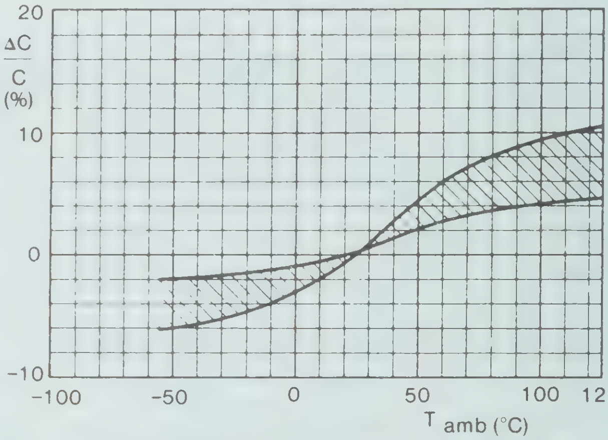


FIG. 1 Typical capacitance as a function of ambient temperature.

The change in capacitance from the initial value measured at 25°C shall not exceed the following percentages:

10% at −55 C;
8% at +85°C; 12% at +125°C.

Voltage rating. These capacitors have a voltage rating over a range of 6 to 100 volts.

Operating temperature range. These capacitors are suitable for operation over a temperature range of −55°C to +85°C.

Voltage derating. When properly derated, these units may be operated over a temperature range of −55° to +125°C. The derated voltage at +125°C is approximately 66 percent of the full rated voltage.

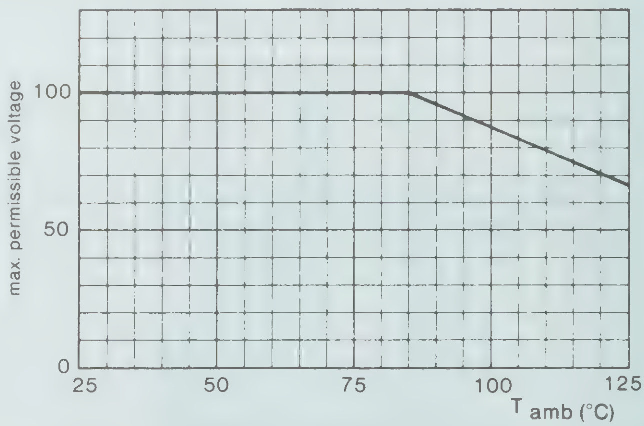


FIG. 2 Maximum permissible voltage as a function of ambient temperature

Permissible ripple voltage. These capacitors may be operated with an impressed ripple (ac) voltage provided the capacitors do not exceed their heat-dissipation limits. Total heat-dissipation limits depend on the ambient operating temperature and the operating frequency. For example: A 10μf of any voltage may be operated at 3 volts RMS, 60 Hz, 25°C (see Fig. 3). When this same capacitor is subjected to different temperatures, or different frequencies, the appropriate derating factors are found in Figs. 4 and 5. If this same 10μf capacitor is subjected to 125° and a ripple frequency of 1000 Hz, the permissible ripple voltage would be 3 x .4 x .18 which equals .216 volts.

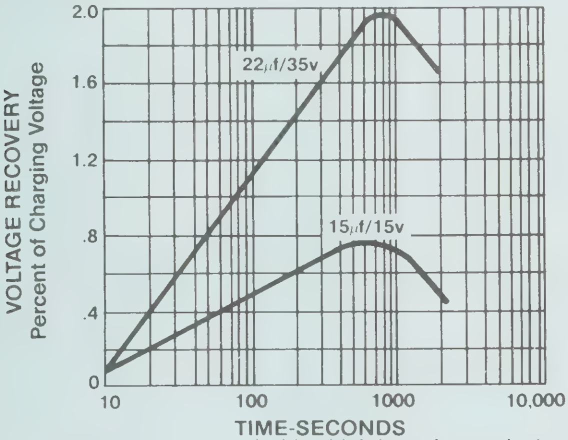
SOLID TANTALUM CAPACITORS

Series and parallel networks:

Series. It is recommended that when these capacitors are connected in series, the maximum voltage across the network should not be greater than the lowest voltage rating of any capacitor in the network, or that voltage divider resistors be used to prevent over voltage on one or more units of the series capacitor group.

Parallel. To obtain a higher capacitance than can be obtained from a single capacitor, a number of units may be connected in parallel. However, the sum of the peak ripple and the applied dc voltage should not exceed the dc working voltage of the unit with the lowest voltage rating. The connecting leads of the parallel network should be large enough to carry the combined currents without reducing the effective capacitance due to series lead resistance.

Dielectric absorption. Dielectric absorption may be observed by the reappearance of potential across the capacitor after it has been shorted and the short removed. This characteristic is important in RC timing circuits, triggering systems, and phase-shift networks. The curves shown in figure 16 were established by charging capacitors for 1 hour at rated voltage and then discharging them through a dead short for 1 minute.



Voltage recovery was measured with a high-impedance electrometer at the intervals given on the curves. Increasing the ambient temperature shifts the curves to the left and decreases the amplitude but does not affect the shape. Shortening charge time, lengthening discharge time, or decreasing charging voltage results in reduction of the peak amplitude of the curve, but has little effect on its shape or relative position.

Comparison with aluminum electrolytics. Tantalum solid electrolytic capacitors differ from aluminum electrolytics in several important aspects: namely, substantially indefinite shelf life, superior low temperature characteristics, complete freedom from electrolyte leakage, and higher operating temperatures.

Mounting. Supplementary mounting means should be used where the application of these capacitors involves vibration frequencies above 55 Hz.

Increased reliability. Failure rate is a function of temperature, applied voltage, and circuit impedance. Increased reliability may be obtained by derating the temperature and applied voltage and increasing circuit impedances.

DC leakage current increases when either voltage or temperature is increased; the rate of increase is greater at the higher values of voltage and temperature. A point can be reached where the dc leakage current will avalanche and attain proportions that will permanently damage the capacitor. Consequently, capacitors should never be operated above their rated temperature and rated voltage for that temperature.

By increasing the circuit impedance, the leakage current is reduced. In life testing the solid tantalum capacitor, the capacitance and dissipation factor are very stable over long periods of time and hence are not a suitable measure of deterioration. Leakage current variation is a better indicator of capacitor condition. In the life test in MIL-C-39003, a maximum impedance of 3 ohms is allowed. It is recommended that a minimum circuit impedance of 3 ohms per applied volt be utilized to attain improved reliability.

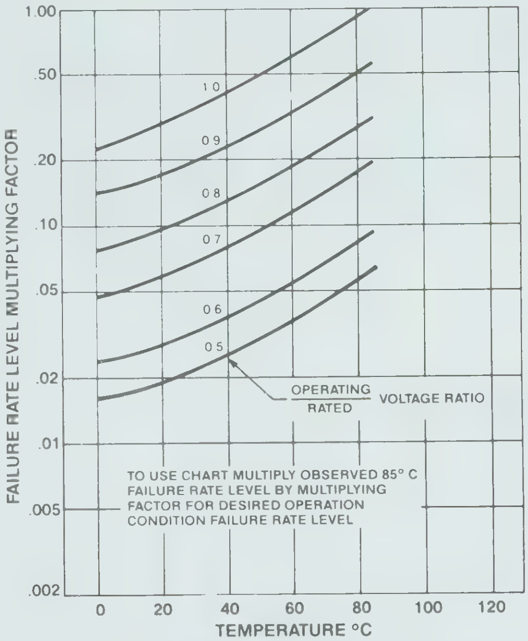


FIG. 17: Failure rate level curves.

NOTE: Multiply the value read from figure 17 by the following applicable multiplying factor.

Circuit Impedance Ohms/Volt	Multiplying Factor	Circuit Impedance Ohms/Volt	Multiplying Factor
3 or greater	1.0	0.5	4.5
2	1.4	0.4	5.1
1	2.8	0.3	6.1
0.9	2.9	0.2	7.5
0.8	3.2	0.15	9.0
0.6	4.0	0.10	12.0

Failure-rate determination. The curves presented on figure - 4 are the best engineering approximation of the reliability characteristics (random failures) for these capacitors when employed repeatedly, within their specification ratings, in complex electronic equipment. These reliability characteristics are based on ground-level severity experience. Failures are considered to be opens, shorts, or radical departures from initial characteristics. The failures are considered to be occurring in an unpredictable manner and in too short a period of time to permit detection through normal preventive maintenance. The curves shown on figure - 4 are based on "catastrophic failures" and will differ from the failure rates established in the specification, since the established failure rates are based on "parametric failures" over long term life tests at rated conditions. Figure - 4 has been extracted from MIL-HDBK-217, "Reliability Stress and Failure Rate Data for Electronic Equipment." The curves have been modified from their original version in that the ordinate has been normalized in order to provide multiplier factors in place of discrete failure rate levels and in order that the multiplying factor for a failure rate at rated conditions is unity. As indicated, these curves are the best estimates based on "catastrophic failures"; however, they can provide an estimate of the relative effect of operating under conditions other than rated.

ADDITIONAL APPLICATION INFORMATION

SOLID TANTALUM CAPACITORS

Leakage Current

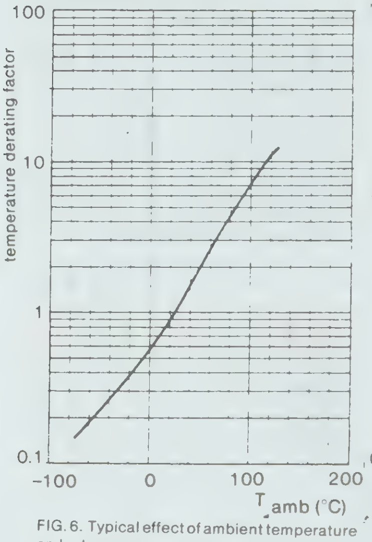


FIG. 6. Typical effect of ambient temperature on leakage current.

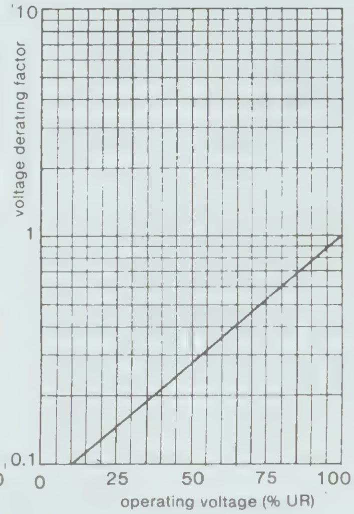


FIG. 7. Typical effect of operating voltage on leakage current.

Equivalent series resistance

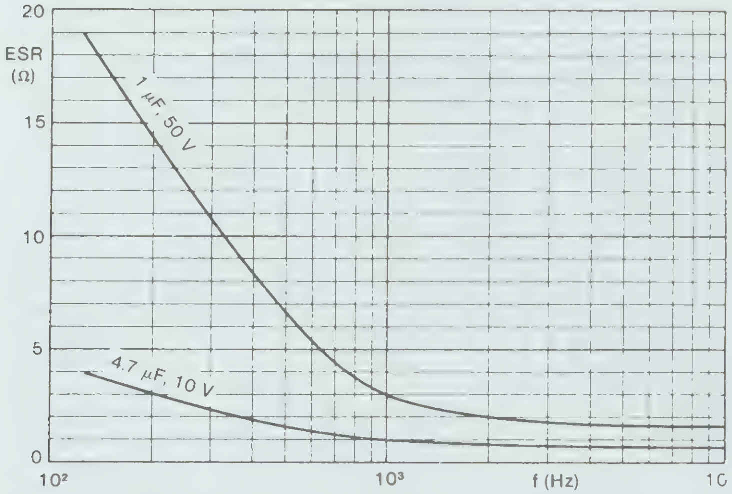


FIG. 8. Typical ESR as a function of frequency; case size A.

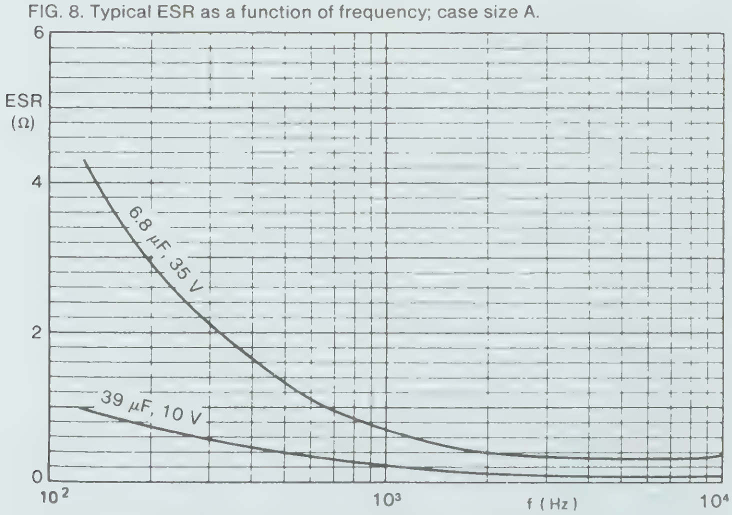


FIG. 9. Typical ESR as a function of frequency; case size B

The sum of the applied dc bias voltage and the peak of the ac ripple voltage should not exceed the dc rated voltage for the applicable ambient temperature. Permissible ac voltage determined from figures 3, 4 and 5, may be applied when the dc voltage is zero or near zero, provided the negative peak of the ac voltage does not exceed the allowable reverse voltage limits of 1 volt at 125°C.

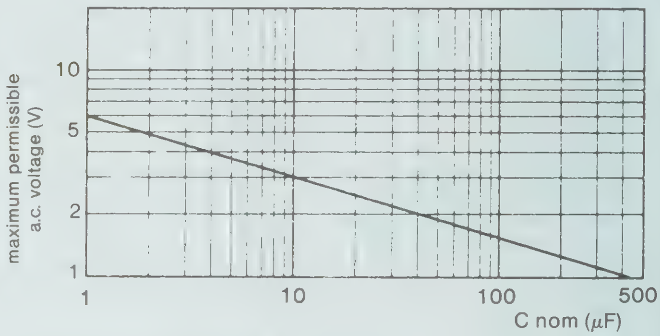


FIG. 3. Maximum permissible ac voltage at 25°C and 60 Hz as a function of nominal capacitance.

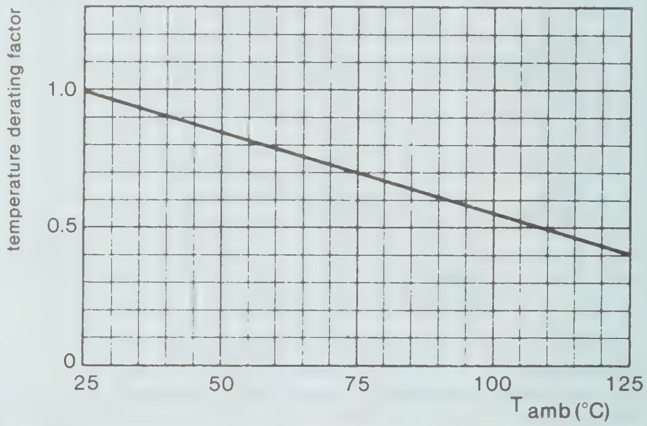


FIG. 4. Effect of temperature on maximum permissible a.c. voltage.

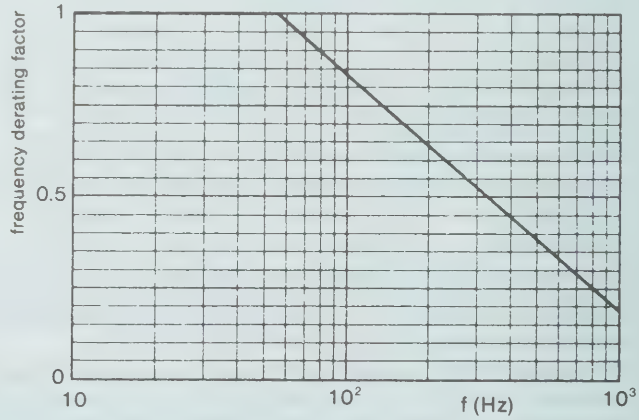
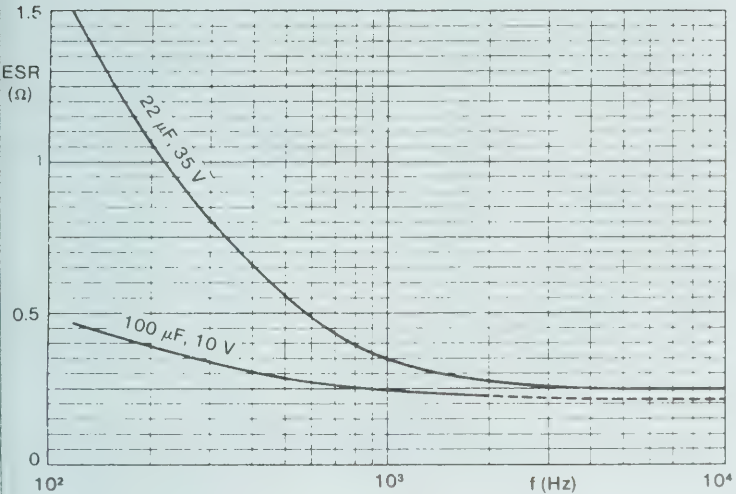


FIG. 5. Effect of frequency on maximum permissible a.c. voltage.

SOLID TANTALUM CAPACITORS



IG. 10. Typical ESR as a function of frequency, case size C.

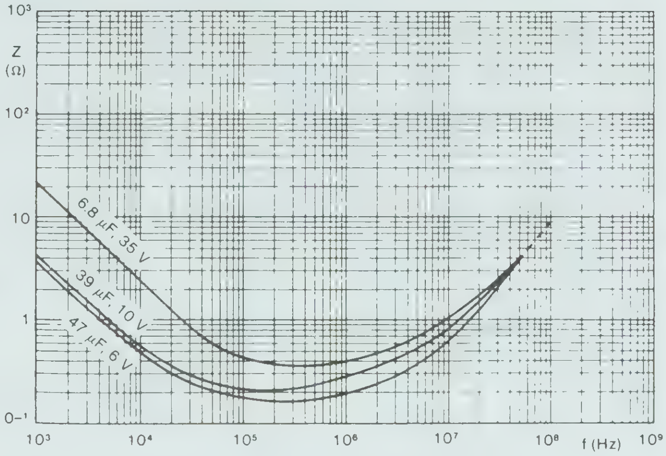
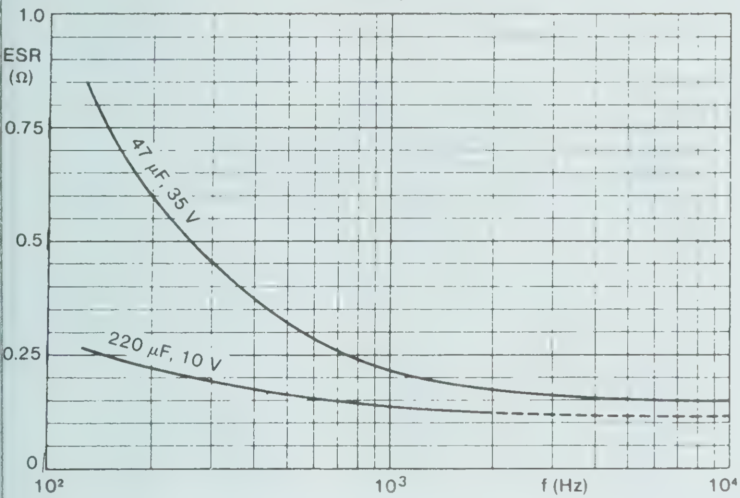


FIG. 13. Typical impedance as a function of frequency at 25°C; case size B.



IG. 11. Typical ESR as a function of frequency, case size D.

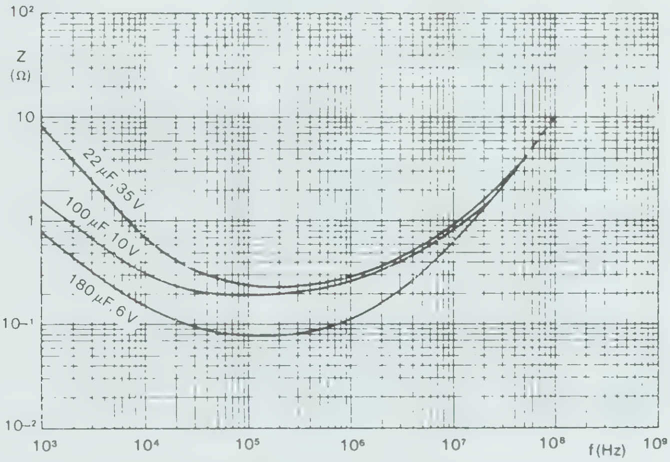


FIG. 14. Typical impedance as a function of frequency at 25°C; case size C.

mpedance

'he impedance is measured by means of a four-terminal circuit Thomson circuit). See the following graphs.

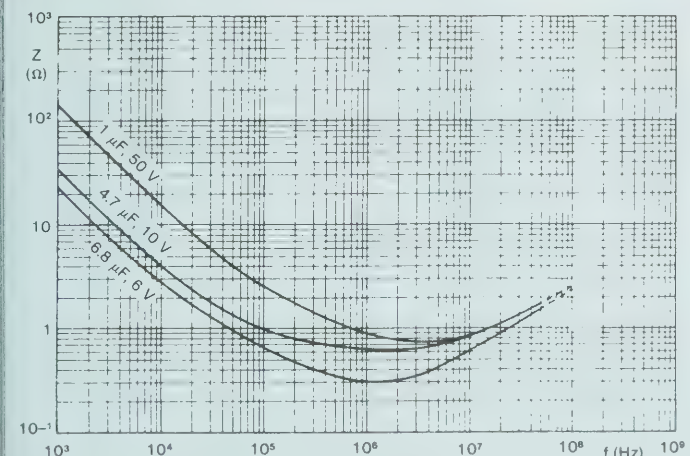


FIG. 12. Typical impedance as a function of frequency at 25°C; case size A.

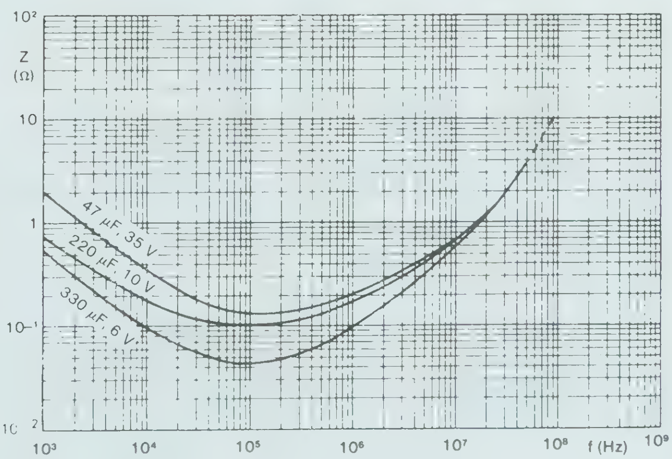


FIG. 15. Typical impedance as a function of frequency at 25°C; case size D.

Tape and Reel Packaging

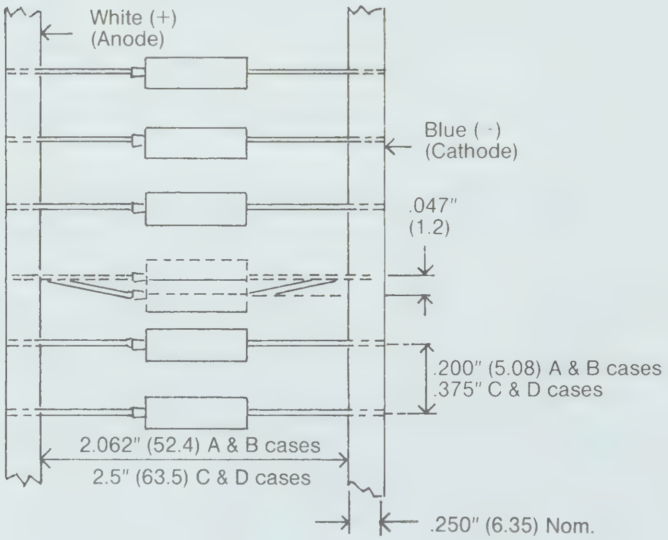
Philips Components offers lead tape and reel packaging for axial leaded tantalum capacitors. Standard tape and reeling is per EIA specification RS-296, optional configurations for specific applications are available.

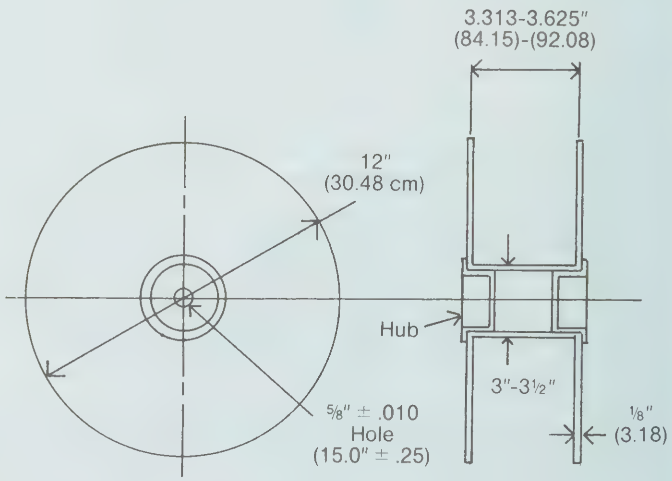
Capacitors are reeled with the positive lead oriented towards the white tape, negative leads oriented toward blue tape. Capacitor lead length may extend a maximum of .0625″ beyond edge of tape. Capacitors are centered in a row between both tapes and will deviate a maximum of ±.031″ from center.

Figures below show the standard Philips Components reel. Distance between flanges of the reel is .218″ (±.093) greater than the overall capacitor length. A minimum of 36″ of leader tape is supplied at both ends of the reeled capacitors.

Standard Reeling Quantities

Case Size	Quantity
A	2500
B	2000
C	500
D	400





STANDARD PACKAGING FOR PHILIPS COMPONENTS TANTALUM CAPACITOR OPERATION. THE FOLLOWING PACKAGING WILL BE USED UNLESS SPECIFIED OTHER-WISE. FOR SPECIFIC INFORMATION ON OTHER PRODUCT LINES, CONTACT THE FACTORY.

SOLID TANTALUM SERIES

	A & B	C & D
CSR13 (40SS)	BULK	TRAY PACK
CSR21 (40ZS)	N/A	TRAY PACK
CSR23 (40XS)	BULK	TRAY PACK
CSR33 (40YS)	BULK	TRAY PACK

Standard Reel is 12" with Kraft interleaves as standard. Pitch is the distance between centerlines of the unit. Class is the distance from inside tape to inside tape and specified as:

CLASS I = 2-1/16"
CLASS II = 2-1/2"
CLASS III = 2-7/8"

WET TANTALUM SERIES

	CASE SIZE	CLASS	PITCH	FULL REEL QTY	MIN. REEL QTY
40YW	ALL	I	.200	3,000	1,000

TAPE & REEL AVAILABLE FOR SOLIDS UPON REQUEST TO EIA SPEC. RS-296

	CASE SIZE	CLASS	PITCH	FULL REEL QTY	MIN. REEL QTY
CSR13 (40SS)	A	I	.200	2,500	1,000
	B	I	.200	2,000	1,000
	C	II	.400	500	400
	D	II	.400	400	300
CSR21 (40ZS)	C	II	.400	500	400
	D	II	.400	400	300
CSR23 (40XS)	A	I	.200	2,500	1,000
	B	I	.200	2,000	1,000
	C	II	.400	500	400
	D	II	.400	400	300
CSR33 (40YS)	A	I	.200	2,500	1,000
	B	I	.200	2,000	1,000
	C	II	.400	500	400
	D	II	.400	400	300

Film Capacitors
QUICK REFERENCE INDEX

PHILIPS MPONENTS SERIES	PHILIPS SERIES 12 NC	CONSTRUCTION	ENCLOSURE	LEAD	VOLTAGE VDC/VAC	CAPACITANCE RANGE (uF)	TOLERANCE %	PAGE
PLICATIONS GUIDE GENERAL (SEE INDIVIDUAL PRODUCTS FOR DETAILS)								406
M CAPACITOR PART NUMBER DESCRIPTION (SEE INDIVIDUAL PRODUCTS FOR DETAILS)								407
LYESTER								
708D1	–	FILM/FOIL	WRAP & POT	AXIAL	80-200 VDC AVAILABLE TO 600	.001 THRU 1.0 AVAILABLE TO 2.0	5,10	408
708A1	–	METALIZED	WRAP & POT	AXIAL	100-200 VDC	.10 THRU 10.0	5,10	411
712A1	365-369	METALIZED	EPOXY	RADIAL	VDC 63,100,250,400,630 VAC 40,63,160,220,220	.001 THRU 6.8	5,10	413
719A1	370,371 344	METALIZED	POTTED	RADIAL	VDC 63,100,250,400 VAC 40,63,160,220	.01 THRU 10.0	5,10	418
YCARBONATE								
708B1	–	METALIZED	WRAP & POT	AXIAL	100-200 VDC	.10 THRU 10.0	5,10	423
719B1	344	METALIZED	POTTED	RADIAL	100-630 VDC 63-220 VAC	.01 THRU 6.8	5,10	425
YSTYRENE								
704C1	424-431	FILM/FOIL	WRAPPED	AXIAL	VDC 63, 160, 250, 630 VAC 25,63,125,200	47PF THRU .039	1,2,5	427
719C1	443	FILM/FOIL	POTTED	RADIAL	VDC 63 VAC 25	100PF THRU .033	1	430
YPROPYLENE								
703E1	460-464	FILM/FOIL	CONFORMAL	AXIAL	VDC 63,160,250,400,630 VAC 40,63,125,160,200	47PF THRU .022	2,5	432
719F1	376	METALIZED	POTTED	RADIAL	VDC 630,1000,1600,2000 VAC 300,400,500,600	.001 THRU .27	5,10	436
719F2	378	METALIZED	POTTED	RADIAL	VDC 250,400,630,1000,1600,2000 VAC 160,200,300,400,500,600	.0033 THRU 3.3	5,10	437
711H	–	METALIZED	MOLDED (CAN)	TERMINAL	VAC 240,370	2 THRU 75	3,6,10	452
YESTER & PAPER—CLASS X VDE APPROVED								
719J1	330	METALIZED	POTTED	RADIAL	250 VAC	.01 THRU 1.0	10,20	458
DUCT TECHNICAL INFORMATION								462
ICAL CHARACTERISTIC CURVES (METALIZED & FILM/FOIL)								460,461

Applications Guide

	GENERAL PURPOSE	TIGHT TOLERANCE	PULSE	SUPPRESSION
	(ALL)	±1%, ±2% FLAT T.C. (POLYPROP./POLYSTY.)	HIGH CURRENT/VAC RMS (POLYPROP./MET.)	PROTECTION FREQUENCY (POLYPROP./MET.)
BLOCKING	•	•	•	
COUPLING/DECOUPLING	•	•	•	•
BYPASSING	•	•	•	•
FILTERING				•
ENERGY STORAGE	F/F		•	•
TIMING	•	•	•	
SMOOTHING	•	•	•	•
TUNING	•	•	•	•
FREQUENCY DISCRIMINATION		•		•
PULSE DISCHARGE	F/F		•	•
ARC SUPPRESSING	F/F		•	•
TRANSIENT VOLTAGE SUPPRESSION	F/F		•	•

F/F = FILM/FOIL ONLY

TEMPERATURE CONVERSION CHART Centigrade–Fahrenheit

°C.	°F.	°C.	°F.	°C.	°F.	°C.	°F.	°C.	°F.
–80	–112.	1	33.8	31	87.8	61	141.8	91	195.8
–70	– 94.	2	35.6	32	89.6	62	143.6	92	197.6
–60	– 65.	3	37.4	33	91.4	63	145.4	93	199.4
–50	– 58.0	4	39.2	34	93.2	64	147.2	94	201.2
–45	– 49.1	5	41.0	35	95.0	65	149.0	95	203.0
–40	– 40.0	6	42.8	36	96.8	66	150.8	96	204.8
–35	– 31.0	7	44.6	37	98.6	67	152.6	97	206.6
–30	– 22.0	8	46.4	38	100.4	68	154.4	98	208.4
–25	– 13.0	9	48.2	39	102.2	69	156.2	99	210.2
–20	– 4.0	10	50.0	40	104.0	70	158.0	100	212.0
–19	– 2.2	11	51.8	41	105.8	71	159.8	105	221.
–18	– .4	12	53.6	42	107.6	72	161.1	110	230.
–17	1.4	13	55.4	43	109.4	73	163.4	115	239.
–16	3.2	14	57.2	44	111.2	74	165.2	120	248.
–15	5.0	15	59.0	45	113.0	75	167.0	130	266.
–14	6.8	16	60.8	46	114.8	76	168.8	140	284.
–13	8.6	17	62.6	47	116.6	77	170.6	150	302.
–12	10.4	18	64.4	48	118.4	78	172.4	160	320.
–11	12.2	19	66.2	49	120.2	79	174.2	170	338.
–10	14.0	20	68.0	50	122.0	80	176.0	180	356.
– 9	15.8	21	69.8	51	123.8	81	177.8	190	374.
– 8	17.6	22	71.6	52	125.6	82	179.6	200	392.
– 7	19.4	23	73.4	53	127.4	83	181.4	250	482.
– 6	21.2	24	75.2	54	129.2	84	183.2	300	572.
– 5	23.0	25	77.0	55	131.0	85	185.0	350	662.
– 4	24.8	26	78.8	56	132.8	86	186.8	400	752.
– 3	26.6	27	80.6	57	134.6	87	188.6	500	932.
– 2	28.4	28	82.4	58	136.4	88	190.4	600	1112.
– 1	30.2	29	84.2	59	138.2	89	192.2	700	1292.
0	32.0	30	86.0	60	140.0	90	194.0	800	1472.
								900	1652.
								1000	1832.

FORMULA °F = (°C x 9/5) +32   °C = (°F-32) x 5/9

PREFIXES OF UNITS

Multiples and sub-multiples	Prefixes	Symbols
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1 000 000 = 10^{4}	mega	M
1 000 = 10^{3}	kilo	k
100 = 10^{2}	hecto	h
10 = 10	deka	da
0.1 = 10^{-1}	deci	d
0.01 = 10^{-2}	centi	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0.000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a

AMERICAN WIRE GAUGE TABLE

Wire Gauge	Nominal Dia. (Inches)	Nominal Dia. (mm)
18	.040	1.02
20	.032	0.81
22	.025	0.64
24	.020	.051

PHILIPS COMPONENTS FILM CAPACITOR GENERAL PART NUMBER DESCRIPTION

Column:	1	2	3	4	5	6 7	8 9 10 11	12	13 14 15	16 17	
Alpha (A) Numeric(N):	N	N	N	A	N	A A	N N N A or N	A	N N N	A A	
Example:	7	0	8	D	1	C C	1 0 3 P	K	2 0 1	A X	(2 Significant Digits)
	7	1	9	C	1	C A	3 3 2 1	F	6 3 0	C A	(3 Significant Digits)
	Film Capacitor Code (7)	Lead Construction	Enclosure Type	Dielectric Material & Construction	Spec. Level	Case Code	Capacitance (picofarad)	Capacitance Tolerance	Voltage	Internal Assignment	

Column 1 = **Philips Components Code**

Column 2 = **Lead Construction**
0 = Axial Leaded
1 = Radial Leaded

Column 3 = **Insulation (Enclosure)**

0 = No Coating	5 = Open
1 = Molded	6 = Open
2 = Epoxy	7 = Open
3 = Conformal	8 = Wrap & Pot
4 = Wrap	9 = Potted

Column 4 = **Dielectric Material**
A = Metalized Polyester
B = Metalized Polycarbonate
C = Polystyrene
D = Polyester and Foil
E = Polypropylene and Foil
F = Polyester and Polypropylene
G = Polycarbonate Foil
H = Polypropylene Metalized
J = Polyester and Paper

Column 5 = **Specification Level or Terminal Description**
1 = Standard
2 = Special designation
3 to 9 = Terminal description for Series 711H

Columns 6 & 7 = **Case Size Code**
See Individual Series specifications for complete definition by Capacitor type.

Columns 8 & 9 = **Significant Digits**
First two (2) Significant Digits of the capacitance in Picofarads

Columns 10 & 11 = **Number of '0' (zeros)**

Part Number Code	Number of '0' (zeros)
1	0
2	00
3	000
4	0000
5	00000
6	000000
7	0000000
8	00000000
9	000000000
0	None

NOTE 1—If Column 10 is numeric a 'P' will appear in Column 11 as a place holder. The numeric in Column 10 then is the number of '0' (zeros) to follow the first (2) Significant Digits shown in Columns 8 & 9 of the part number.
Example: 10,000PF = 0.01μF = 103P
(Columns 8,9,10,&11)

NOTE 2—If a numeric appears in Column 10 & 11 no 'P' will be used & Columns 8, 9, & 10 become the first (3) Significant Digits of the capacitance in Picofarads. The numeric in Column 11 then represents the number of '0' (zeros) to follow the first (3) Significant Digits in Columns 8, 9, & 10 of the part number.
Example:
12700 PF = 0.0127μF = 1272
(Columns 8, 9, 10, & 11)
(This coding is only used for small capacitance values. When 3 place capacitance accuracy is required—see the Motor Run Section for Special Capacitance Coding on Fractional Capacitance Values.)

Column 12 = **Capacitance Tolerance %**

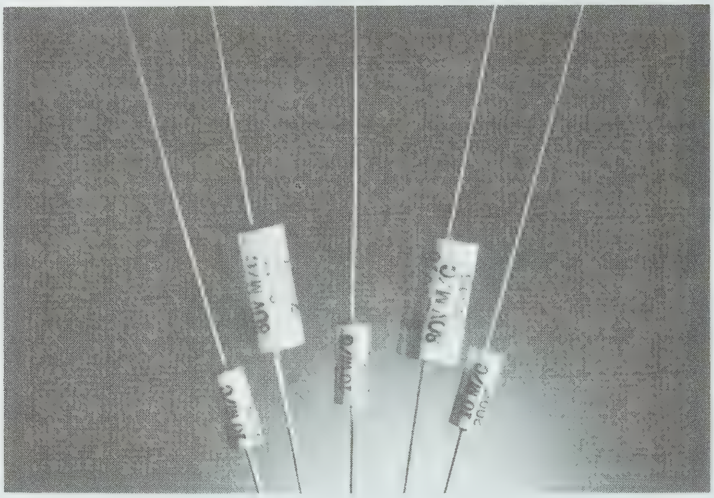
A = Special	J = ±5%	W = ±3.5%
F = ±1%	H = ±6%	
G = ±2%	K = ±10%	
L = ±3%	M = ±20%	

Columns 13, 14 & 15 = **Voltage Rating (VDC)**
Voltage Rating—First two numbers are significant digits, third digit gives number of zeros. Refer to specific data sheet to determine VDC and/or VAC.

Columns 16 & 17 = **Internal Assignment**
Use to denote special requirements: lead spacing, lead length, tape and reel, etc.

SERIES 708D1

Polyester & Foil Capacitors



DESCRIPTION:

Series 708D1 polyester/foil capacitors are round units wound with aluminum foil and capacitor grade polyester (polyethylene terephthalate) film dielectric. These compact rolls incorporate welded tinned copper clad steel wire leads and are wrapped with electrical grade tape and end filled. Philips Components has achieved a goal of providing a film dielectric unit which when applied within its rating will give the highest order or reliability per dollars cost known to the industry.

FEATURES:

Electrical

- Dielectric Withstanding—250% x Rated (VDC) for one sec.
- Dissipation Factor (% @ 25°C)
  $\leq$ 1.0uFD @ 1 KHz $\leq$ 0.6%
  $>$ 1.0uFD @ 60Hz $\leq$ 0.6%
- Insulation Resistance @ 25°C
  $\leq$0.5uFD 100000 MΩ min.
  $>$ 0.5uFD 50000 MΩ MFD min.
- Maximum Capacitance Change with Temp.
  @ −55°C −10%
  @ +85°C +10%
  @ +125°C +15%
- Standard Voltage Ratings—80, 100 & 200VDC @ −55°C to 85°C. Operating temperature to 125°C with proper voltage derating
- Voltage Derating @ 125°C is 50% of rated voltage.

Mechanical

- Small size
- Lightweight-non metallic case welded lead construction providing strong positive contact terminations.
- Lead strength—5 lb. axially
- Available bulk or tape & reel

(Quantity ordered and/or unit size may limit tape & reel availability)

HOW TO SPECIFY:

Series 708D1 Capacitors may be specified using the following designation:
(See General Part Number Description for more details)

708D1 CC 103P K 201 AX

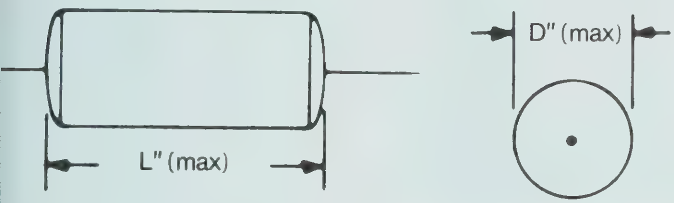
- **708D1** — Series
- **CC** — Case Size
- **103P** — Capacitance in (pF)
  In this example the first two digits represent significant figures and last digit indicated the number of zeros to follow.
  P = Place Holder
- **K** — Tolerance
  J = ± 5%
  K = ±10%
- **201** — Voltage at 85°C
  800 = 80V
  101 = 100V
  201 = 200V
- **AX** — Internal Assignment

SERIES 708D1

Polyester & Foil Capacitors

SPECIFICATIONS

OUTLINE DRAWING



LEAD LENGTH: 1.63" MIN. BOTH SIDES

TYPICAL MARKING EXAMPLE	
Nominal Capacitance	0.10uf
Tolerance	±10%
Rated Voltage DC	200VDC
Philips Components Series	708D1
Date Code (Yr & Wk)	9023

708D1 SERIES

CAP VALUE UF	POLYESTER FILM/FOIL 80VDC: PHILIPS COMPONENTS PART NUMBER*	MAX. DIMENSIONS IN INCHES LENGTH	DIAMETER	LEAD SIZE AWG	POLYESTER FILM/FOIL 200 VDC: PHILIPS COMPONENTS PART NUMBER*	MAX. DIMENSIONS IN INCHES LENGTH	DIAMETER	LEAD AWG.
.0010	708D1AA102P*800AX	.406	.153	22	708D1CC102P*201AX	.450	.185	22
.0012	AA122	.406	.153	22	CC122	.450	.185	22
.0015	AA152	.406	.153	22	CC152	450	185	22
.0018	AA182	.406	.153	22	CC182	.450	185	22
.0022	AA222	.406	.153	22	CC222	.450	185	22
.0027	AA272	.406	.153	22	CC272	450	185	22
.0033	AA332	.406	.153	22	CC332	450	185	22
.0039	AA392	.406	.153	22	CC392	450	185	22
.0047	AA472	.406	.153	22	CC472	450	185	22
.0056	NOT AVAILABLE USE 200 VOLT DEVICE				CC562	450	185	22
.0068					CC682	450	185	22
.0082					CC822	.450	185	22
.010					CC103	.450	185	22
.012	708D1EC123P*800AX	.530	.185	22	EH123	.530	229	22
.015	EC153	.530	.185	22	EH153	.530	.229	22
.018	EC183	.530	.185	22	HH183	.594	.229	22
.022	EC223	.530	.185	22	HH223	.594	229	22
.027	EH273	.530	.229	22	HJ273	.594	.250	22
.033	EH333	.530	.229	22	HJ333	.594	250	22
.039	HH393	.594	.229	22	HP393	.594	315	22
.047	HH473	.594	.229	22	HP473	.594	315	22
.056	HJ563	.594	.250	22	MP563	719	315	22
.068	HJ683	.594	.250	22	MP683	.719	315	22
.082	HP823	.594	.315	22	MR823	719	328	22
.10	HP104	.594	.315	22	MR104	719	328	22
.12	MP124	.719	.315	22	XS124	969	343	22
.15	MP154	.719	.315	22	XS154	969	343	22
.18	MV184	.719	.343	22	HS184	1 28	343	22
.22	MV224	.719	.343	22	HS224	1 28	343	22
.27	XS274	.969	.343	20	GN274	1 25	562	22
.33	XS334	.969	.343	20	GN334	1 25	562	20
.39	HV394	1.28	.375	20	RO394	1 59	578	20
.47	HV474	1.28	.375	20	RO474	1 59	578	20
.56	NOT AVAILABLE USE 100 VOLT DEVICE				VU564	1 72	630	20
.68					VU684	1 72	630	20
.82					CE824	1 90	750	20
1.00					CE105	1.90	750	20

CAP VALUE UF	POLYESTER FILM/FOIL 100VDC				
.27	708D1GC274P*101AX	1.25	.436	20	.032
.33	GC334	1.25	.436	20	.032
.39	GK394	1.25	.531	20	.032
.47	GK474	1.25	.531	20	.032
.56	RN564	1.59	.562	20	.032
.68	RN684	1.59	.562	20	.032
.82	RQ824	1.59	.610	20	.032
1.00	RQ105	1.59	.610	20	.032

NOTE: Higher voltage ratings and other tolerances available upon special request.

* INSERT APPROPRIATE LETTER INTO PART NUMBER FOR TOLERANCE

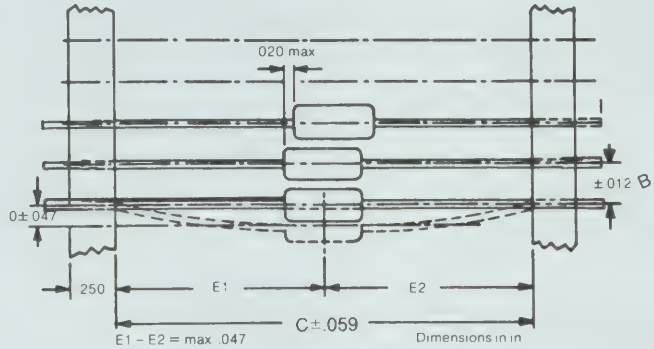
J = ± 5%
K = ± 10% STANDARD

NOTICE: MISAPPLICATION SUCH AS EXCEEDING DESIGN LIMITS MAY RESULT IN DESTRUCTION OR EXPLOSION OF CAPACITORS.

4 Film Capacitors

SERIES 708D1

Tape & Reel Packaging Specifications

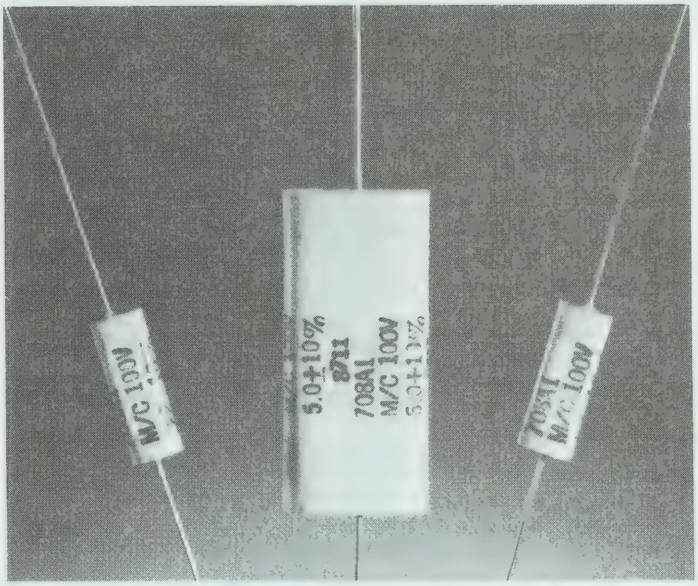


TAPE & REEL PER EIA RS296 (LATEST ISSUE)

A DIA. RANGE	B UNIT SPACING	C TAPE SPACING
.197 max	.200	*
.394 max	.400	*
.594 max	.600	*

Notes: 1) For "C" all "B" dimensions are available in tape spacings of 2.062, 2.500, or 2.874 inches (some restrictions may apply)
2) Reel diameter is 14 inches
3) Special Tape & Reel dimensions available on request. Contact the factory.

Metalized Polyester Capacitor



DESCRIPTION

Series 708A1 metalized polyester (polyethylene terephthalate) dielectric wrapped with tape and potted in a flat oval configuration with resistance welded tinned copper clad steel leads.

FEATURES

Electrical

- Dielectric Withstanding—200% x rated (VDC) for one sec.
- Dissipation Factor @ 25°C $\leq$1.0% @ 1KHz
- Insulation Resistance @ 25°C 15000Ω x MFD min.
- Maximum Capacitance change with temp.
  @ −55°C −5%
  @ +85°C +10%
  @ +125°C +20%
- Standard voltage ratings—100 & 200VDC @ −55°C to +85°C operation at temperatures to −125°C with proper voltage derating.
- Voltage derating @ 125°C is 50% of rated voltage.

Mechanical

- Small size
- Flat—space saving configuration
- Long trouble-free life
- Self-healing
- Solvent resistance
- Lead strength—5 lb. pull
- Available Bulk only

HOW TO SPECIFY

Philips Components Series 708A1 Capacitors can be completely specified using the following designation:
(See General Part Number Description for more details)

708A1 JJ 104P K 201 AX

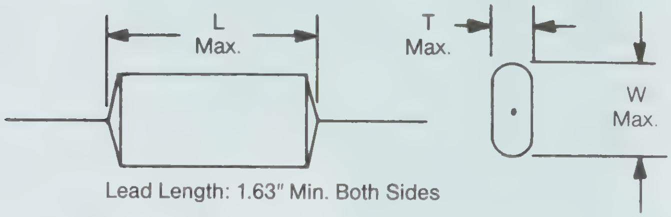
- **708A1** — **Series**
- **JJ** — **Case Code**
- **104P** — **Capacitance in (pF)**
  In this example the first two digits represent significant figures and last digit indicates the number of zeros to follow.
  P = Place Holder
- **K** — **Tolerance**
  J = ± 5%
  K = ±10%
- **201** — **Voltage at 85°C**
  101 = 100V
  201 = 200V
- **AX** — **Internal Assignment**

SERIES 708A1

Metalized Polycarbonate Capacitors

4 *Film Capacitors*

OUTLINE DRAWING



Lead Length: 1.63" Min. Both Sides

TYPICAL MARKING EXAMPLE	
Philips Components rated voltage (DC)	100V
Type	708A1
Nominal Capacitance (UF) Tol.	.10 ±10%

100VDC AT 85°C					
CAP VALUE UF	PHILIPS COMPONENTS PART NUMBER*	MAXIMUM DIMENSIONS IN INCHES			
		"L" LENGTH INCHES	"W" WIDTH INCHES	"T" THICKNESS INCHES	**LEAD AWG.**
.10	708A1JC104P*101AX	.656	.311	.195	22
.15	JG154	.656	.358	.218	22
.22	OB224	.782	.311	.171	22
.33	OG334	.782	.358	.218	22
.47	OJ474	.782	.374	.249	22
.68	OO684	.782	.421	.311	22
1.0	VL105	.906	.452	.280	22
1.5	ZR155	1.031	.530	.327	20
2.0	ZV205	1.031	.593	.374	20
3.0	JZ305	1.344	.624	.405	20
4.0	RV405	1.594	.718	.374	20
5.0	RC505	1.594	.765	.436	20
8.0	ZG805	1.844	.905	.483	20
10.0	ZO106	1.844	.983	.577	20

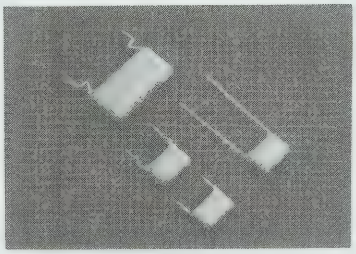
200VDC AT 85°C					
CAP VALUE UF	PHILIPS COMPONENTS PART NUMBER*	MAXIMUM DIMENSIONS IN INCHES			
		"L" LENGTH INCHES	"W" WIDTH INCHES	"T" THICKNESS	**LEAD AWG.**
.10	708A1JJ104P*201AX	.656	.374	.249	22
.15	JO154	.656	.436	.311	22
.22	OL224	.782	.421	.280	22
.33	OR334	.782	.514	.327	20
.47	OX474	.782	.577	.389	20
.68	ZV684	1.031	.577	.374	20
1.0	ZC105	1.031	.640	.436	20
1.5	JD155	1.344	.640	.452	20
2.0	JD205	1.344	.780	.452	20
3.0	RI305	1.594	.827	.499	20
4.0	RM405	1.594	.952	.546	20
5.0	ZO505	1.844	.968	.577	20
8.0	CE805	1.906	1.249	.749	18
10.0	CF106	1.906	1.965	.812	18

*INSERT APPROPRIATE LETTER PART NUMBER FOR TOLERANCE:
J=± 5%
K=±10% STANDARD

NOTICE: MISAPPLICATION SUCH AS EXCEEDING DESIGN LIMITS MAY RESULT IN DESTRUCTION OR EXPLOSION OF CAPACITORS.

SERIES 712A1 (TYPE MKT)

Metalized Polyester Capacitors (Philips 2222-365 thru 369 Series)



DESCRIPTION

Series 712A1 Metalized Polyester (Polyethylene Terephthalate) Film Dielectric encapsulated in a hard epoxy case with solder coated wire leads. Their high ratio of capacitance to volume affords an inherently high packaging density and excellent compatability with PC board assembly.

APPLICATIONS

For general purpose and industrial use in electronic equipment, e.g., for coupling and decoupling applications.

FEATURES

Electrical

- Rated Capacitance Range—.001 to 6.8μF
- Climatic Category—40/100/56
- Related Specification—IEC 384-2
- Dielectric Withstanding—160% x rated (VDC) terminal to terminal. 200% x rated (VDC) between interconnected terminals and case.
- Dissipation Factor

capacitance	frequency		
	1 kHz	10 kHz	100 kHz
$C < 0{,}1\mu F$	$\leq 75 \times 10^{-4}$	$\leq 130 \times 10^{-4}$	$< 225 \times 10^{-4}$
$0{,}1\ \mu F < C \leq 0{,}47\mu F$	$< 75 \times 10^{-4}$	$\leq 130 \times 10^{-4}$	$\leq 300 \times 10^{-4}$
$0{,}47\ \mu F < C \leq 1\mu F$	$< 75 \times 10^{-4}$	$\leq 130 \times 10^{-4}$	
$C > 1\mu F$	$< 75 \times 10^{-4}$	$\leq 150 \times 10^{-4}$	

- Insulation resistance—
  The insulation resistance is measured after a voltage has been applied for 1 min. ±5 s, the voltage being 10±1V for the 63V version, 100 ±15V for the 100V, 250V and 400V versions and 500 ±50V for the 630V version at T_{amb} = 20°C.

  R between terminations, for $C_R \leq 0{,}33\mu F$
  63V and 100V versions >15,000MΩ
  250V, 400V and 630V versions >30,000MΩ

  RC between terminations, for $C_R > 0{,}33\mu F$
  63V and 100V versions > 5,000s
  250V, 400V and 630V versions >10,000s

  R between interconnected terminations and case (foil method) >30,000MΩ

- Standard Voltage Ratings—63, 100, 250, 400 & 630VDC @+85°C
- Storage Temperature Range—−40°C to +100°C (Bulk Only)
- Storage Temperature Range—−25°C to +40°C @≤80% RH (Tape & Reel or Ammo Pak)

Maximum pulse load

rated voltage V	maximum pulse load (V/μs)					
	L=7,5 mm	L=10 mm	L=12,5 mm	L=17,5 mm	L=26 mm	L=30 mm
63	55	9	15			
100	55	18	24	10	4	3,5
250		35	35	14	6	5
400		95	55	22	10	8
630			80	35	14	12

The maximum pulse load values in the table are valid for pulse voltages equal to the rated voltage. For lower pulse voltages the given values may be multiplied by U_R/applied voltage.

Note:
If the pulse requirement is satisfied, a check must be made to ascertain that the maximum dissipation is not exceeded.

Mechanical

- Low cost
- Self-healing
- The body will withstand most solvent and aqueous liquids
- Long trouble-free life
- Tape & reel available [.200" (5mm) lead spacing)]
- Strong lead pull and bend capability
- Lead Solderability—tested in accordance with MIL-STD-202, Method 208.
- Resistance to soldering heat with pre-heating capacitors mounted on a 1.6 mm board with non-plated holes.
  Body Temp.: 80°C
  Bath Temp.: 260°C
  Dwell Time: 2 x 5 s with interim free period of 5 s

4

Film Capacitors

SERIES 712A1

Metalized Polyester Capacitors

HOW TO SPECIFY

Series 712A1 capacitors can be completely specified using the following designation:
(See General Part Number Description for more details)

712A1 BD 104P K 251 # K

- **712A1** — **PC Series** (Epoxy Coated)
- **BD** — **Case Size**
- **104P** — **Capacitance in (pF)**: In this example the first two digits represent significant figures and last digit indicates the number of zeros to follow. P=Place Holder
- **K** — **Tolerance**: M=±20%; K=±10% STANDARD; J=±5% SPECIAL
- **251** — **Voltage at 85°C**: 630=63V; 101=100V; 251=250V; 401=400V; 631=630V
- **#** — Specification: L=Long Lead (bulk); S=Short Lead (bulk); T=Tape & Reel; A=Ammo Pack; W=Special
- **K** — **Lead Configuration**

Lead Spacing	Crimp Code	**Straight Code**
100	M**	
.200	G	S
.300	H	T
.400	K	A
.600	L	B*
.900	F	D*
1.100	N	E*

*Not released; special only. Contact factory for information.

****Special Crimp** Contact the factory

Note: # denotes lead length, tape & reel or ammo pack.

LEAD SPACING IN (mm)	DIMENSIONS of CRIMP "A"	
	CRIMP A Inches	CRIMP A mm
.200 (5.00)	.055/.079	1.4/2.0
.300 (7.62)	.059/.098	1.5/2.5
.400 (10.16)	.059/.118	1.5/3.0
.600 (15.24)	.078/.154	2.0/3.9
.900 (22.86)	.078/.154	2.0/3.9
1.100 (27.94)	.078/.154	2.0/3.9

NOTICE: MISAPPLICATION SUCH AS EXCEEDING DESIGN LIMITS MAY RESULT IN DESTRUCTION OR EXPLOSION OF CAPACITORS.

DIMENSIONS OF EPOXY CREEPAGE "C" ON STRAIGHT LEADS
<u>.200, .300, and .400 Lead Spacings</u> ≤1.5 mm (.059 inch)
<u>.600, .900 and 1.10 Lead Spacings</u> Special Only—Not Released ≤3 or 5 mm (.118 or .197 inch) Contact factory for information.

LEAD LENGTH VS PART NUMBER CODE

As part number codes are very important in description, the following table is presented for reference:

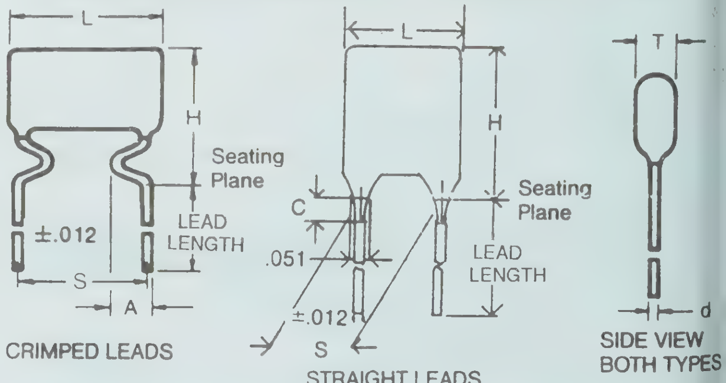
LEAD SPACING	CRIMP CODE		STRAIGHT CODE	
INCHES (mm)	SHORT	LONG	SHORT	LONG
0.200 (5.08)	SG	LG	SS	LS
0.300 (7.62)	SH	LH	ST	LT
0.400 (10.16)	SK	LK	SA	LA
0.600 (15.24)	SL	LL	SB*	LB*
0.900 (22.86)	SF	LF	SD*	LD*
1.10 (27.94)	SN	LN	SE*	LE*

*Not released. Special only. Contact factory for information. Minimums will apply.

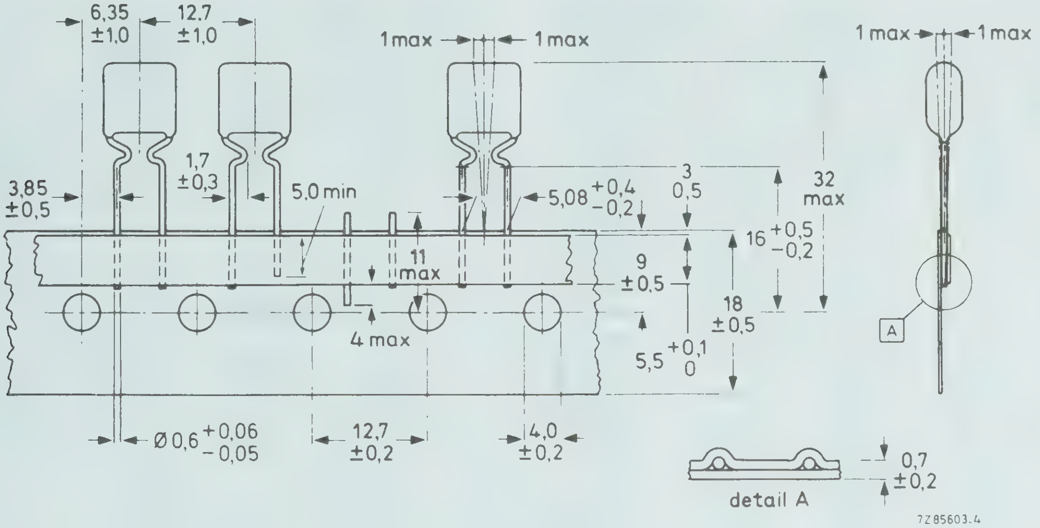
LEAD LENGTH

CUT & FORM	STRAIGHT
Short = 4 +1 mm −.5 mm (.138/.197 inches)	Short = 4 +1mm −.5 mm (.138/.197 inches)
.200 & .300 Spacings Long = 17 ±4 mm (.512/.826 inches)	Long = 22 ±4 mm (.708/1.02 inches)
.400 & .600 Spacings Long = 19 ±4 mm (.591/.827 inches)	
.900 Spacing Long = 25 ±4 mm (.826/1.14 inches)	
1.10 Spacing Long = 24 ±4 mm (.787/1.16 inches)	

CASE OUTLINE DRAWING All Dimensions in Inches

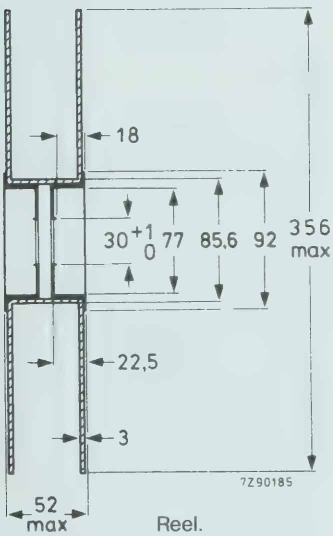


SERIES 712A1
Tape & Reel/Ammo Pak Specifications

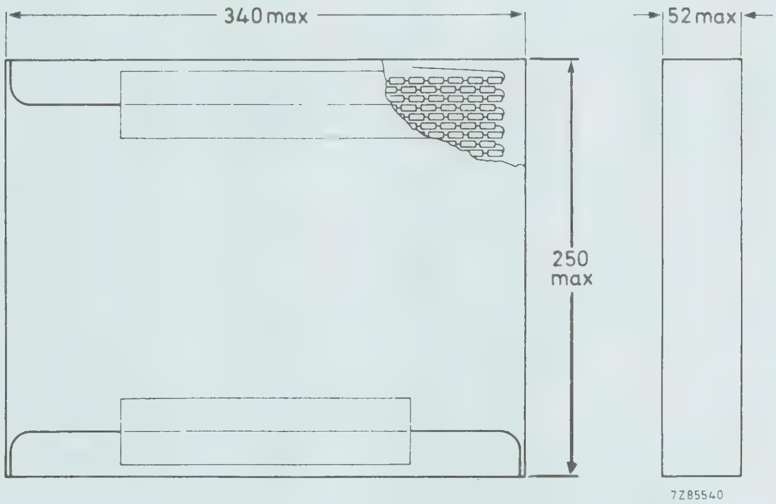


Capacitors on tape.

Cumulative pitch error: 1,0 mm/20 pitches.
Maximum 0.5% (Tape & Reel)/5% Ammo Pak of the total number of capacitors per reel may be missing, but not more than 2 consecutive positions may be vacant.



Reel.



Capacitors on tape in ammunition packing.

Characteristics concerning taped capacitors:	
Pull-out force of the component	≥5 N
Pull-off force of adhesive tape	≥ 6N
Tearing force of tape	≥15 N
Storage conditions:	
Storage temperature range	−25 to +40°C
Relative humidity	≤80%

SERIES 712A1

Metalized Polyester Capacitors

63 VDC (40 VAC RMS)

CAP UF	MEPCO/CENTRALAB PART NUMBER	
	.200 SPACING (2e)	
.047	712A1XA473P*630	#G
.056	XA563	#G
.068	XA683	#G
.082	XA823	#G
.10	XA104	#G
.12	XA124	#G
.15	XC154	#G
.18	XC184	#G
.22	XC224	#G
.27	XE274	#G
.33	XE334	#G
.39	XE394	#G
.47	XF474	#G
.56	XF564	#G
.68	XE684	#G
.82	XF824	#G
1.0	XG105	#G
	.200 SPACING (2e 3e)	
.12	712A1AB124P*630	#G
.15	AB154	#G
.18	AB184	#G
.22	AB224	#G
.27	AC274	#G
.33	AD334	#G
.39	AD394	#G
.47	AE474	#G
.56	AE564	#G
.68	AE684	#G
.82	AE824	#G
1.0	AE105	#G
	.300 SPACING	
.12	712A1AB124P*630	SH
.15	AB154	SH
.18	AB184	SH
.22	AB224	SH
.27	AC274	SH
.33	AD334	SH
.39	AD394	SH
.47	AE474	SH
.56	AG564	SH
.68	AG684	SH
.82	AG824	SH
1.0	AG105	SH

100 VDC (63 VAC RMS)

CAP UF	MEPCO/CENTRALAB PART NUMBER	
	.200 SPACING (2e)	
.010	712A1XA103P*101	#G
.012	XA123	#G
.015	XA153	#G
.018	XA183	#G
.022	XA223	#G
.027	XA273	#G
.033	XA333	#G
.039	XA393	#G
.047	XC473	#G
.056	XC563	#G
.068	XC683	#G
.082	XC823	#G
.10	XC104	#G
	.200 SPACING (2e 3e)	
.039	712A1AB393P*101	#G
.047	AB473	#G
.056	AB563	#G
.068	AB683	#G
.082	AB823	#G
.10	AB104	#G
.12	AC124	#G
.15	AD154	#G
.18	AD184	#G
.22	AE224	#G
.27	AF274	#G
.33	AF334	#G
.39	AF394	#G
.47	AF474	#G
	.300 SPACING	
.039	712A1AB393P*101	SH
.047	AB473	SH
.056	AB563	SH
.068	AB683	SH
.082	AB823	SH
.10	AB104	SH
.12	AC124	SH
.15	AD154	SH
.18	AD184	SH
.22	AE224	SH
.27	AF274	SH
.33	AG334	SH
.39	AG394	SH
.47	AG474	SH
	.400 SPACING	
.056	712A1BB563P*101	SK
.068	BB683	SK
.082	BB823	SK
.10	BB104	SK
.12	BB124	SK
.15	BB154	SK
.18	BC184	SK
.22	BD224	SK
	.600 SPACING	
.27	712A1GD274P*101	SL
.33	GD334	SL
.39	GD394	SL
.47	GE474	SL
.56	GE564	SL
.68	GF684	SL
.82	GG824	SL
1.0	GJ105	SL
	.900 SPACING	
1.2	712A1MF125P*101	SF
1.5	MF155	SF
1.8	MF185	SF
2.2	MG225	SF
2.7	MJ275	SF
3.3	ML335	SF
	1.10 SPACING	
3.9	712A1RL395P*101	SN
4.7	RN475	SN
5.6	RS565	SN
6.8	RU685	SN

250 VDC (160 VAC RMS)

CAP UF	MEPCO/CENTRALAB PART NUMBER	
	.200 SPACING (2e 3e)	
.018	712A1AB183P*251	#G
.022	AB223	#G
.027	AB273	#G
.033	AB333	#G
.039	AB393	#G
.047	AB473	#G
	.300 SPACING	
.018	712A1AB183P*251	SH
.022	AB223	SH
.027	AB273	SH
.033	AB333	SH
.039	AB393	SH
.047	AB473	SH
	.400 SPACING	
.027	712A1BB273P*251	SK
.033	BB333	SK
.039	BB393	SK
.047	BB473	SK
.056	BC563	SK
.068	BC683	SK
.082	BD823	SK
.10	BD104	SK
	.600 SPACING	
.12	712A1GD124P*251	SL
.15	GD154	SL
18	GE184	SL
.22	GF224	SL
.27	GG274	SL
.33	GH334	SL
	.900 SPACING	
.39	712A1MD394P*251	SF
.47	ME474	SF
.56	MF564	SF
.68	MG684	SF
.82	MH824	SF
1.0	MJ105	SF
	1.10 SPACING	
1.2	712A1RJ125P*251	SN
1.5	RL155	SN
1.8	RN185	SN
2.2	RS225	SN

400 VDC (220 VAC RMS)

CAP UF	MEPCO/CENTRALAB PART NUMBER	
	.200 SPACING (2e 3e)	
0033	712A1AB332P*401	#G
.0039	AB472	#G
.0047	AB562	#G
0056	AB682	#G
0068	AB822	#G
0082	AB103	#G
010	AB123	#G
012	AB153	#G
015		#G
	.300 SPACING	
.0039	712A1AB392P*401	SH
.0047	AB472	SH
.0056	AB562	SH
.0068	AB682	SH
.0082	AB822	SH
.010	AB103	SH
.012	AB123	SH
.015	AB153	SH
	.400 SPACING	
.0010	712A1BB102P*401	SK
.0012	BB122	SK
.0015	BB152	SK
.0018	BB182	SK
.0022	BB222	SK
.0027	BB272	SK
.0033	BB332	SK
.0039	BB392	SK
.0047	BB472	SK
.0056	BB562	SK
.0068	BB682	SK
.0082	BB822	SK
.010	BB103	SK
.012	BB123	SK
.015	BB153	SK
.018	BB183	SK
.022	BB223	SK
.027	BC273	SK
.033	BC333	SK
	.600 SPACING	
.039	712A1GD393P*401	SL
.047	GD473	SL
056	GD563	SL
.068	GD683	SL
.082	GE823	SL
.10	GF104	SL
12	GG124	SL
.15	GH154	SL
	.900 SPACING	
.18	712A1MD184P*401	SF
.22	ME224	SF
.27	MF274	SF
.33	MG334	SF
.39	MH394	SF
.47	MK474	SF
	1.10 SPACING	
.56	712A1RK564P*401	SN
.68	RL684	SN
.82	RN824	SN
1.0	RS105	SN

630 VDC (220 VAC RMS)

CAP UF	MEPCO/CENTRALAB PART NUMBER	
	.400 SPACING	
.010	712A1BD103P*631	SK
.012	BD123	SK
.015	BE153	SK
.018	BF183	SK
.022	BG223	SK
	.600 SPACING	
.027	712A1GE273P*631	SL
.033	GF333	SL
.039	GG393	SL
.047	GH473	SL
.056	GJ563	SL
.068	GK683	SL
	.900 SPACING	
.082	712A1ME823P*631	SF
.10	MF104	SF
.12	MH124	SF
.15	MJ154	SF
.18	ML184	SF
.22	MM224	SF
	1.10 SPACING	
.27	712A1RR274P*631	SN
.33	RR334	SN
.39	RS394	SN
.47	RU474	SN

1. 'A' Case Codes @.200" (5.08mm) Spacing Tape & Reel or Ammo Pak Only-No Bulk
2. 'A' Case Codes @ .300" (7.62mm) Spacing are available bulk only.

TYPICAL MARKING EXAMPLE (TOP VIEW)

CAP (PF OR UF) TOLERANCE CODE
VOLTAGE (DC) DIELECTRIC CODE (MKT)
.400" (10.16) & LARGER LEAD SPACING

PHILIPS	0.1	K	CODE OF ORIGIN
	250	MKT	

AP (PF OR UF) W/O SYMBOL TOLERANCE CODE
OLTAGE (DC) W/O SYMBOL DIELECTRIC CODE (MKT)
0" (5.08mm/7.62mm) or .300" (7.62m) LEAD SPACINGS

0.1	K
250	MKT

CAP (PF OR UF)—W/O SYMBOL
TOL. CODE VOLTAGE (DC)—W/O SYMBOL
.200" (5.08mm) LEAD SPACINGS

0.047
K 63

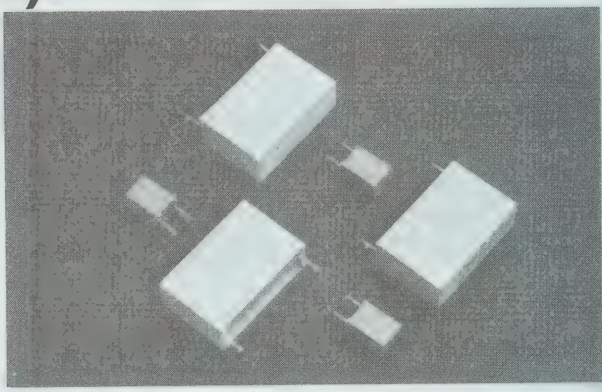
CASE SIZE TABLE
DIMENSIONS IN INCHES (mm) MAXIMUM

CASE SIZE CODE	"L" LENGTH		"H" HEIGHT INCHES CUT/FORM		"H" HEIGHT INCHES STRAIGHT		"T" THICKNESS		"S" SPACING		"D" WIRE DIA. LEAD SIZE	
	INCHES	(mm)	INCHES	(mm)	INCHES	(mm)	INCHES	(mm)	INCHES	(mm)	AWG	INCHES
".200 INCH LEAD SPACING" (2e) (5.08mm)												
XA	.295	7.5	.492	12.5	.295	7.5	.138	3.5	.200	5.08	22	.025
XC	.295	7.5	.531	13.5	.335	8.5	.177	4.5	.200	5.08	22	.025
XE	.295	7.5	.571	14.5	.413	10.5	.217	5.5	.200	5.08	22	.025
XF	.295	7.5	.610	15.5	.453	11.5	.236	6.0	.200	5.08	22	.025
".200 INCH LEAD SPACING" (2e-3e) (5.08mm)												
AB	.394	10.0	.531	13.5	.315	8.0	.157	4.0	.200	5	22	.025
AC	.413	10.5	.551	14.0	.335	8.5	.177	4.5	.200	5	22	.025
AD	.413	10.5	.571	14.5	.354	9.0	.197	5.0	.200	5	22	.025
AE	.413	10.5	.591	15.0	.374	9.5	.217	5.5	.200	5	22	.025
AF	.413	10.5	.610	15.5	.413	10.5	.236	6.0	.200	5	22	.025
".300 INCH LEAD SPACING" (3e) (7.62mm)												
AB	.394	10.0	.472	12.0	.335	8.5	.157	4.0	.300	7.62	22	.025
AC	.413	10.5	.512	13.0	.355	9.0	.177	4.5	.300	7.62	22	.025
AD	.413	10.5	.531	13.5	.374	9.5	.197	5.0	.300	7.62	22	.025
AE	.413	10.5	.551	14.0	.394	10.0	.217	5.5	.300	7.62	22	.025
AF	.413	10.5	.571	14.5	.413	10.5	.236	6.0	.300	7.62	22	.025
AG	.413	10.5	.591	15.0	.453	11.5	.236	6.0	.300	7.62	22	.025
".400 INCH LEAD SPACING" (10.16mm)												
BB	.492	12.5	.472	12.0	.374	9.5	.157	4.0	.400	10.16	22	.025
BC	.492	12.5	.492	12.5	.394	10.0	.177	4.5	.400	10.16	22	.025
BD	.492	12.5	.512	13.0	.413	10.5	.197	5.0	.400	10.16	22	.025
BE	.492	12.5	.531	13.5	.433	11.0	.217	5.5	.400	10.16	22	.025
BF	.492	12.5	.551	14.0	.492	12.5	.236	6.0	.400	10.16	22	.025
BG	.492	12.5	.571	14.5	.473	12.0	.256	6.5	.400	10.16	22	.025
".600 INCH LEAD SPACING" (15.24mm)												
GD	.689	17.5	.551	14.0	*Not released		.197	5.0	.600	15.24	20	.032
GE	.689	17.5	.571	14.5	only specials		.217	5.5	.600	15.24	20	.032
GF	.689	17.5	.591	15.0	with 5mm		.236	6.0	.600	15.24	20	.032
GG	.689	17.5	.630	16.0	creepage on		.256	6.5	.600	15.24	20	.032
GH	.689	17.5	.630	16.0	leads. Con-		.276	7.0	.600	15.24	20	.032
GJ	.689	17.5	.650	16.5	tact factory		.295	7.5	.600	15.24	20	.032
GK	.689	17.5	.669	17.0	for additional		.315	8.0	.600	15.24	20	.032
GL	.689	17.5	.689	17.5	info.		.335	7.5	.600	15.24	20	.032
".900 INCH LEAD SPACING" (22.86mm)												
MD	1.02	26	.669	17.0			.197	5.0	.900	22.86	20	.032
ME	1.02	26	.689	17.5	*Not released		.217	5.5	.900	22.86	20	.032
MF	1.02	26	.709	18.0	only specials		.236	6.0	.900	22.86	20	.032
MG	1.02	26	.728	18.5	with 5mm		.256	6.5	.900	22.86	20	.032
MH	1.02	26	.748	19.0	creepage on		.276	7.0	.900	22.86	20	.032
MJ	1.02	26	.768	19.5	leads. Con-		.295	7.5	.900	22.86	20	.032
MK	1.02	26	.788	20.0	tact factory		.315	8.0	.900	22.86	20	.032
ML	1.02	26	.807	20.5	for additional		.335	8.5	.900	22.86	20	.032
MM	1.02	26	.846	21.5	info.		.374	9.5	.900	22.86	20	.032
"1.100 INCH LEAD SPACING" (27.94mm)												
RJ	1.18	30	.768	19.5	*Not released		.295	7.5	1.100	27.94	20	.032
RK	1.18	30	.788	20.0	only specials		.315	8.0	1.100	27.94	20	.032
RL	1.18	30	.807	20.5	with 5mm		.335	8.5	1.100	27.94	20	.032
RN	1.18	30	.846	21.5	creepage on		.374	9.5	1.100	27.94	20	.032
RR	1.18	30	.866	22.0	leads. Con-		.394	10.0	1.100	27.94	20	.032
RS	1.18	30	.905	23.0	tact factory		.433	11.0	1.100	27.94	20	.032
RU	1.18	30	.945	24.0	for additional		.473	12.0	1.100	27.94	20	.032
RX	1.18	30	.984	25.0	info.		.512	13.0	1.100	27.94	20	.032

4 Film Capacitors

SERIES 719A1 (TYPE MKT)

Metalized Polyester Capacitors (Philips-344, 370 & 371 Series)



DESCRIPTION

Nugget Series 719A1 metalized polyester (polyethylene terephthalate) dielectric encased in a rectangular epoxy encapsulated flame retardant polypropylene case with sturdy solder coated copper pins, they lend themselves readily to insertion into printed circuit cards, motherboards, and similar modular assemblies.

FEATURES

Electrical

- Rated capacitance range .0039 to 10 μf
- Climatic category 55/100/56
- Related specification IEC 384-2
- CECC 30-401-039 2nd Edition (except 2222344 63V & 250V (.082 -1μfd)
- Dielectric Withstanding—160% x rated (VDC) terminal to terminal. 200% x rated (VDC) between interconnected terminals and case.
- Maximum pulse load

rated voltage V	maximum pulse load (V/μs)					
	L=7,2 mm	L=10 mm	L=13 mm	L=17,5 mm	L=26 mm	L=31 mm
63	30	9	15	6	3	2
100	55	18	24	10	4	3,5
250		35	35	14	6	5
400		95	55	22	10	8

The maximum pulse load values in the table are valid for pulse voltages equal to the rated voltage. For lower pulse voltages the given values may be multiplied by the U_R/applied voltage.

Note:
If the pulse load requirement is satisfied, a check must be made to ascertain that the maximum dissipation is not exceeded.

- Dissipation Factor

style	capacitance	tangent of loss angle		
		1 kHz	10 kHz	100 kHz
2222 370 2222 371	$C \leq 0{,}1\ \mu F$ $0{,}1\ \mu F < C \leq 0{,}47\ \mu F$ $0{,}47\ \mu F < C \leq 1\ \mu F$	$\leq 75 \times 10^{-4}$ $\leq 75 \times 10^{-4}$ $\leq 75 \times 10^{-4}$	$\leq 130 \times 10^{-4}$ $\leq 130 \times 10^{-4}$ $\leq 130 \times 10^{-4}$	$\leq 200 \times 10^{-4}$ $\leq 300 \times 10^{-4}$
2222 344	$C \leq 0{,}1\ \mu F$ $0{,}1\ \mu F < C \leq 1\ \mu F$ $C > 1\ \mu F$	$\leq 75 \times 10^{-4}$ $\leq 75 \times 10^{-4}$ $\leq 75 \times 10^{-4}$	$\leq 130 \times 10^{-4}$ $\leq 130 \times 10^{-4}$ $\leq 150 \times 10^{-4}$	$\leq 250 \times 10^{-4}$

- Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 min ± 5 s, the voltage being 10 $\pm$1V for the 63V version and 100 $\pm$15V for the 100V, 250V and 400V versions at $T_{amb} = 20°C$.

R between terminations, for $C_R \leq 0{,}33\ \mu F$
- 63V and 100V versions $>$15,000 MΩ
- 250V and 400V versions $>$30,000 MΩ

RC between terminations, for $C_R > 0{,}33\ \mu F$
- 63 V and 100 V versions $>$ 5,000 s
- 250 V and 400 V versions $>$10,000 s

R between interconnected terminations and case (foil method) $>$30,000 MΩ

- Standard Voltage Ratings—63, 100, 250 & 400 VDC @ +85°C
- Storage Temperature Range—−55°C to 100°C
- Storage Temperature Range—−25°C to 40°C @≤ 80% RH (Tape & Reel or Ammo Pak)

Mechanical

- Low cost
- Precisely dimensioned case—permits high package density
- Mounting feet
- Self-healing
- Lead strength—5 lb. pull
- Lead solderability—tested in accordance with MIL-STD-202, Method 208.
- Resistance to soldering heat with pre-heating capacitors mounted on a 1.6 mm board with non-plated holes.
  Body Temp.: 80°C
  Bath Temp.: 260°C
  Dwell Time: 2 x 5 s with interim free period of 5 s

HOW TO SPECIFY

Series 719A1 Capacitors can be completely specified using the following designation:
(See General Part Number Description for more details)

719A1 GD 104P K 251 # B

719A1 — Series

GD — Case Size

104P — Capacitance in (pF)
In this example the first two digits represent significant figures and last digit indicated the number of zeros to follow.
P = Place Holder

K — Tolerance
J = ± 5%
K = ±10% STANDARD

251 — Voltage at 85°C
630=63V
101=100V
251=250V
401=400V

 # — Specification
L = Long Lead (bulk)
S = Short Lead (bulk)
Tape & Reel
T=18mm +2mm −0mm
B=16mm +.3mm −.5mm
C=16.5mm ±.3mm

A=18mm +2mm −0mm
X=16mm +.3mm −.5mm
Y=16.5mm ±.3mm

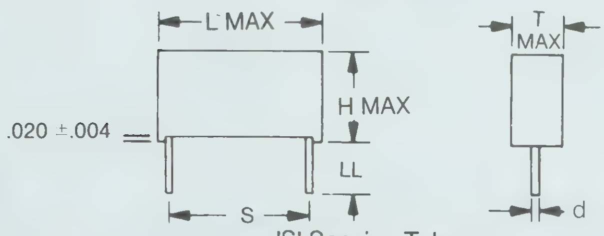
B — Lead Configuration
Straight

Lead Code	Lead Spacing
G	0.200 (5.08 mm)
H	0.300 (7.62 mm)
A	0.394 (10 mm)
B	0.591 (15 mm)
D	0.886 (22.5 mm)
E	1.080 (27.5 mm)

"LL" LEAD LENGTH*			LEAD DIA.*
LEAD SPACING	SHORT LEAD	LONG LEAD	"d"
.200 &.300	.137 / .196	.984 / 1.063	.024
.400 & UP	.157 / .236	NOT AVAILABLE	.032

*INCHES, MIN./MAX.

OUTLINE DRAWING



'S' Spacing Tolerance
5.08 mm & 7.62 mm lead spacing +.012 −.015
all other spacings ±.012"

"X" CASE SIZES (.200 SPACING) ARE AVAILABLE BULK, SHORT OR LONG LEADS. ALSO TAPE & REEL OR AMMO PACK IS AVAILABLE FOR "X" CASE SIZES.
"A" CASE SIZES (.300 SPACING) ARE AVAILABLE BULK, SHORT OR LONG LEADS. TAPE & REEL IS ALSO AVAILABLE FOR "A" CASE SIZES.
"C", "G", "M", AND "R" CASE SIZES ARE AVAILABLE BULK ONLY WITH SHORT LEADS.
SOME RESTRICTIONS APPLY - NOT ALL CASE SIZE & CV VALUES AVAILABLE AS BULK, TAPE & REEL, OR AMMO PACKED.

NOTICE: MISAPPLICATION SUCH AS EXCEEDING DESIGN LIMITS MAY RESULT IN DESTRUCTION OR EXPLOSION OF CAPACITORS.

4 Film Capacitors

SERIES 719A1

Metalized Polyester Capacitors

CASE SIZE TABLE SERIES 719A1

CASE SIZE CODE	DIMENSION IN INCHES (MM) MAXIMUM								
	"L" LENGTH INCHES	MM	"H" LENGTH INCHES	MM	"T" THICKNESS INCHES	MM	"S" SPACING INCHES	MM	LEAD SIZE AWG
XA	.283	7.2	.256	6.5	.098	2.5	.200	5.08	22
XB	.283	7.2	.315	8	.138	3.5	.200	5.08	22
XC	.283	7.2	.354	9	.177	4.5	.200	5.08	22
XD	.283	7.2	.394	10	.197	5	.200	5.08	22
XE	.283	7.2	.433	11	.236	6	.200	5.08	22
AX	.394	10	.256	6.5	.098	2.5	.300	7.62	22
AA	.394	10	.315	8	.118	3	.300	7.62	22
AB	.394	10	.354	9	.157	4	.300	7.62	22
AC	.394	10	.414	10.5	.197	5	.300	7.62	22
AD	.394	10	.453	11.5	.236	6	.300	7.62	22
CA	.511	13	.394	10	.177	4.5	.394	10	20
CB	.511	13	.433	11	.197	5	.394	10	20
CC	.511	13	.472	12	.236	6	.394	10	20
GD	.689	17.5	.433	11	.197	5	.591	15	20
GE	.689	17.5	.472	12	.236	6	.591	15	20
GF	.689	17.5	.511	13	.276	7	.591	15	20
GG	.689	17.5	.571	14.5	.335	8.5	.591	15	20
MH	1.02	26	.610	15.5	.256	6.5	.886	22.5	20
MJ	1.02	26	.650	16.5	.295	7.5	.886	22.5	20
MK	1.02	26	.689	17.5	.335	8.5	.886	22.5	20
ML	1.02	26	.748	19	.374	9.5	.886	22.5	20
RM	1.22	31	.788	20	.433	11	1.08	27.5	20
RN	1.22	31	.886	22.5	.511	13	1.08	27.5	20
RG	1.22	31	.984	25	.591	15	1.08	27.5	20

TYPICAL MARKING EXAMPLE

(FOR .200 & .300 LEAD SPACINGS)

TOP VIEW:

Rated Cap. (nf or μf), Tol. Code	0.10 K

SIDE VIEW:

Rated VDC	100 VDC
Code for Dielectric and	MKT
Code for Factory of Origin	☐
Philips Type No.	370
Manufacturer I.D.	PH
Date Code (Year & Week)	8914

(FOR .400 & LARGER LEAD SPACINGS)

(TOP VIEW)

Cap/Tolerance/Voltage (VDC)	0.10/10/250
MKT Factory Code	MKT 344 ☐
Philips Identification Symbol	

METALIZED POLYESTER TYPE 719A1

63 VDC (40 VAC RMS)

CAP UF	PHILIPS COMPONENTS PART NUMBER	
	.200 SPACING	
.056	719A1XA563P*630	#G
.068	XA683	#G
.082	XA823	#G
.10	XA104	#G
.12	XB124	#G
.15	XB154	#G
.18	XB184	#G
.22	XB224	#G
.27	XC274	#G
.33	XC334	#G
.39	XC394	#G
.47	XC474	#G
.56	XE564	#G
.68	XE684	#G
.82	XE824	#G
1.0	XE105	#G
	.300 SPACING	
.056	719A1AX563P*630	#H
.068	AX683	#H
.082	AX823	#H
.10	AX104	#H
.12	AA124	#H
.15	AA154	#H
.18	AA184	#H
.22	AA224	#H
.27	AB274	#H
.33	AB334	#H
.39	AB394	#H
.47	AB474	#H
.56	AC564	#H
.68	AC684	#H
.82	AD824	#H
1.0	AD105	#H
	.394 SPACING	
.18	719A1CA184P*630	SA
.22	CA224	SA
.27	CB274	SA
.33	CB334	SA
.39	CC394	SA
.47	CC474	SA
	.591 SPACING	
.56	719A1GE564P*630	SB
.68	GE684	SB
.82	GF824	SB
1.0	GF105	SB
1.2	GG125	SB
1.5	GG155	SB
	.886 SPACING	
1.8	719A1MH185P*630	SD
2.2	MH225	SD
2.7	MK275	SD
3.3	MK335	SD
3.9	ML395	SD
4.7	ML475	SD
	1.08 SPACING	
5.6	719A1RM565P*630	SE
6.8	RM685	SE
8.2	RN825	SE
10.0	RN106	SE

100 VDC (63 VAC RMS)

CAP UF	PHILIPS COMPONENTS PART NUMBER	
	.200 SPACING	
.0039	719A1XA392P*101	#G
.0047	XA472	#G
.0056	XA562	#G
.0068	XA682	#G
.0082	XA822	#G
.01	XA103	#G
.012	XA123	#G
.015	XA153	#G
.018	XA183	#G
.022	XA223	#G
.027	XA273	#G
.033	XA333	#G
.039	XA393	#G
.047	XA473	#G
.056	XB563	#G
.068	XB683	#G
.082	XB823	#G
.10	XB104	#G
	.300 SPACING	
.018	719A1AX183P*101	#H
.022	AX223	#H
.027	AX273	#H
.033	AX333	#H
.039	AX393	#H
.047	AX473	#H
.056	AA563	#H
.068	AA683	#H
.082	AA823	#H
.10	AA104	#H
.12	AB124	#H
.15	AB154	#H
.18	AB184	#H
.22	AB224	#H
.27	AC274	#H
.33	AC334	#H
.39	AD394	#H
.47	AD474	#H
	.394 SPACING	
.082	719A1CA823P*101	SA
.10	CA104	SA
.12	CA124	SA
.15	CA154	SA
.18	CA184	SA
.22	CA224	SA
	.591 SPACING	
.27	719A1GD274P*101	SB
.33	GD334	SB
.39	GD394	SB
.47	GD474	SB
.56	GE564	SB
.68	GE684	SB
.82	GF824	SB
1.0	GF105	SB
	.886 SPACING	
1.2	719A1MH125P*101	SD
1.5	MH155	SD
1.8	MK185	SD
2.2	MK225	SD
2.7	ML275	SD
3.3	ML335	SD
	1.08 SPACING	
3.9	719A1RM395P*101	SE
4.7	RM475	SE
5.6	RN565	SE
6.8	RM685	SE
8.2	RG825	SE
10.0	RG106	SE

250 VDC (160 VAC RMS)

CAP UF	PHILIPS COMPONENTS PART NUMBER	
	.300 SPACING	
.0082	719A1AX822P*251	#H
.010	AX103	#H
.012	AX123	#H
.015	AX153	#H
.018	AA183	#H
.022	AA223	#H
.027	AA273	#H
.033	AA333	#H
.039	AB393	#H
.047	AB473	#H
.056	AC563	#H
.068	AC683	#H
.082	AD823	#H
.10	AD104	#H
	.394 SPACING	
.039	719A1CA393P*251	SA
.047	CA473	SA
.056	CA563	SA
.068	CA683	SA
	.591 SPACING	
.082	719A1GD823P*251	SB
.10	GD104	SB
.12	GD124	SB
.15	GD154	SB
.18	GE184	SB
.22	GE224	SB
.27	GF274	SB
.33	GF334	SB
	.886 SPACING	
.39	719A1MH394P*251	SD
.47	MH474	SD
.56	MH564	SD
.68	MH684	SD
.82	MK824	SD
1.0	MK105	SD
	1.08 SPACING	
1.2	719A1RM125P*251	SE
1.5	RM155	SE
1.8	RM185	SE
2.2	RM225	SE

400 VDC (220 VAC RMS)

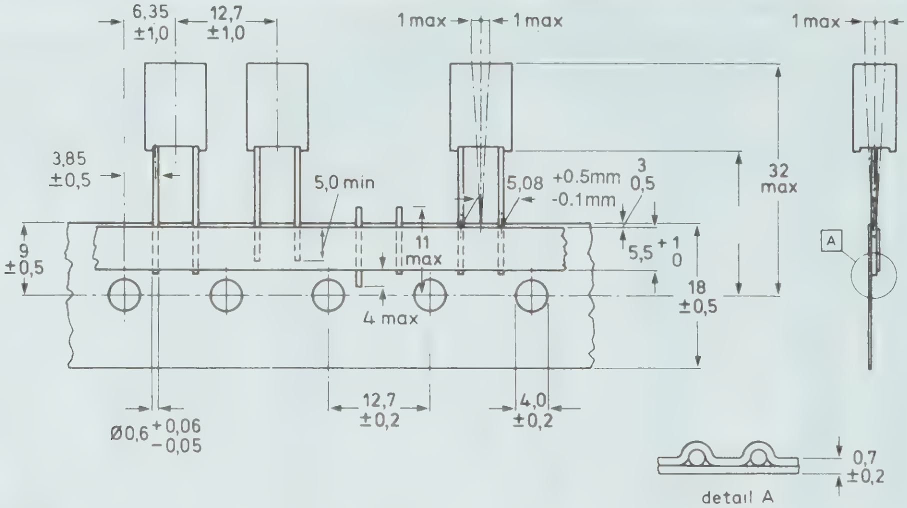
CAP UF	PHILIPS COMPONENTS PART NUMBER	
	.300 SPACING	
.0039	719A1AX392P*401	#H
.0047	AX472	#H
.0056	AX562	#H
.0068	AX682	#H
.0082	AA822	#H
.010	AA103	#H
	.394 SPACING	
.010	719A1CA103P*401	SA
.012	CA123	SA
.015	CA153	SA
.018	CA183	SA
.022	CA223	SA
.027	CA273	SA
.033	CA333	SA
	.591 SPACING	
.039	719A1GD393P*401	SB
.047	GD473	SB
.056	GE563	SB
.068	GE683	SB
.082	GF823	SB
.10	GF104	SB
.12	GG124	SB
.15	GG154	SB
	.886 SPACING	
.18	719A1MH184P*401	SD
.22	MH224	SD
.27	MJ274	SD
.33	MJ334	SD
.39	ML394	SD
.47	ML474	SD
	1.08 SPACING	
.56	719A1RM564P*401	SE
.68	RM684	SE
.82	RN824	SE
1.0	RN105	SE

NOTE—# Denotes Lead Length,Tape & Reel,or AMMO Pack

SERIES 719A1

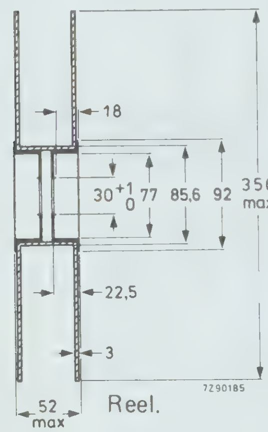
Tape & Reel/AMMO Pack Specifications

5.08mm Pitch

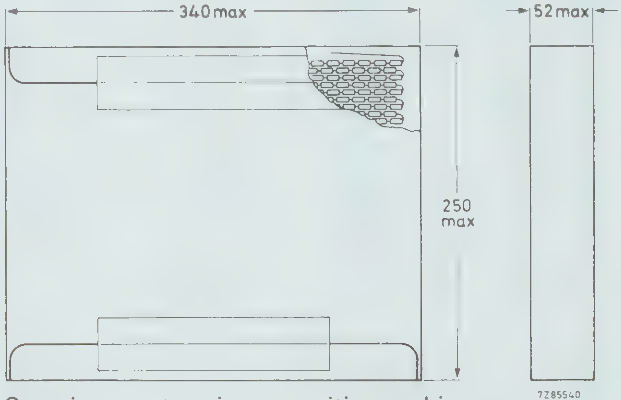


Standoff Height		
18mm	+2mm −0mm	(Standard)
16mm	+0.3mm −0.5mm	(Special)
16.5mm	±0.3mm	(Special)

NOTE:
1) Cumulative pitch error: 1,0 mm/20 pitches.
2) Max 0.5% (TAPE & REEL) 5% (AMMO PACK) of the total number of capacitors per reel may be missing, but no more than 2 consecutive positions may be vacant.

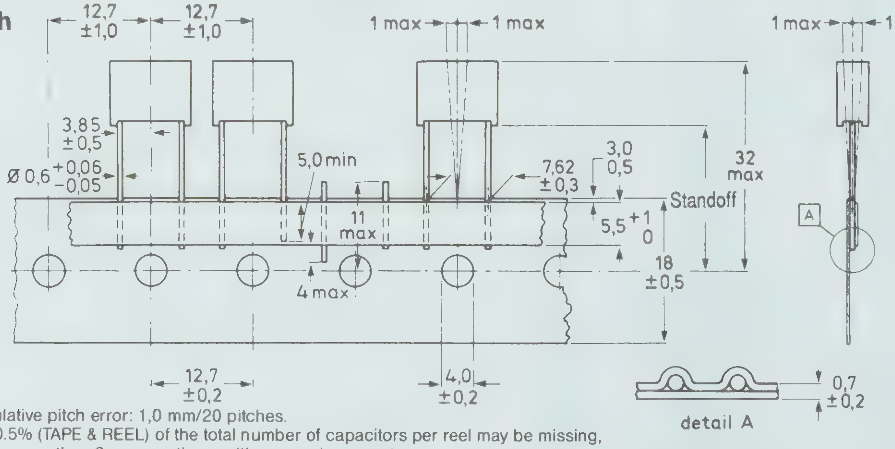


Reel.



Capacitors on tape in ammunition packing.

7.62mm Pitch



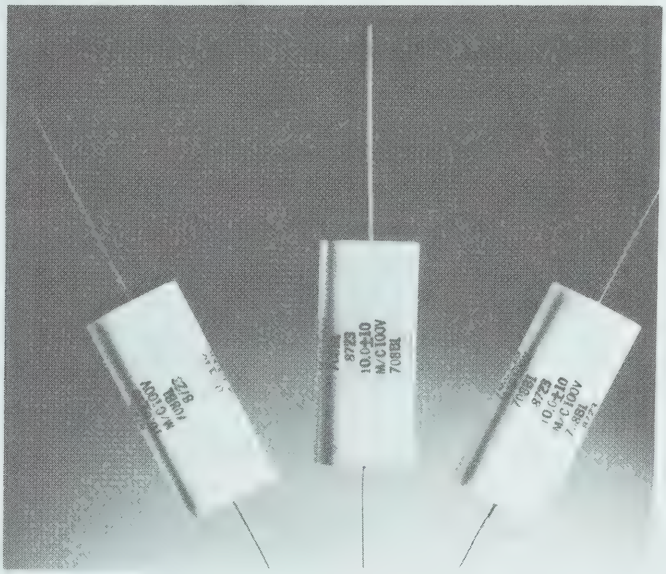
Standoff Height		
16.5mm	±0.3mm	(Standard)
18mm	+2mm −0mm	(Special)
16mm	+0.3mm −0.5mm	(Special)

NOTE:
1) Cumulative pitch error: 1,0 mm/20 pitches.
2) Max 0.5% (TAPE & REEL) of the total number of capacitors per reel may be missing, but no more than 2 consecutive positions may be vacant.

Characteristics concerning taped capacitors:	
Pull-out force of the component	≥5 N
Pull-off force of adhesive tape	≥6 N
Tearing force of tape	≥15 N

Storage conditions:	
Storage temperature range	−25 to +40°C
Relative humidity	≤80%

Metalized Polycarbonate Capacitors



DESCRIPTION

Series 708B1 metalized polycarbonate dielectric wrapped with tape and end potted in a flat oval configuration with resistance welded axial tinned copper clad steel leads.

FEATURES

Electrical

- Dielectric Withstanding—150% x Rated (VDC) for one minute
- Dissipation Factor @ 25°C
  $\leq$1.0uFD @ 1KHz $\leq$0.3%
  $>$1.0uFD @ 60Hz $\leq$0.3%
- Insulation Resistance @ 25°C
  $\leq$0.10uFD 300000 MΩ min.
  $>$0.10uFD 30000 MΩ x MFD min.
- Maximum Capacitance Change with Temp.
  @ −55°C −2.5%
  @ +85°C +1.5%
  @ +125°C +2.5%
- Standard Voltage Ratings—100 & 200 VDC @ −55°C to +85°C. Operating temperatures to +125°C with proper voltage derating.
- Voltage derating @ 125°C is 50% of rated voltage.

Mechanical

- Small size
- Flat-surface-saving configuration
- Long trouble-free life
- Self-healing
- Solvent resistant
- Low temperature coefficient
- Low dissipation factor
- Ideal for AC voltage application
- Superior high-frequency characteristics
- Lead strength—5 lb. pull
- Available Bulk Only

HOW TO SPECIFY

Series 708B1 Capacitors may be specified using the following designation:
(See General Part Number Description for more details)

708B1	LJ	104P	K	201	AX
Series	Case Size Code	Capacitance In (pF)	Tolerance	Voltage At 85°C	Internal Assignment

Case Size Code

Tolerance
J = ±5%
K = ±10% STANDARD

Capacitance In (pF)
In this example the first two digits represents significant figures and last digit indicates the number of zeros to follow.
P = Place Holder

Voltage At 85°C
101=100V
201=200V

SERIES 708B1

Metalized Polycarbonate Capacitors

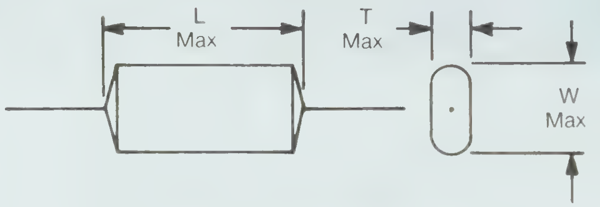
708B1 SERIES

100VDC AT 85°C					
CAP VALUE UF	PHILIPS COMPONENTS PART NUMBER*	DIMENSIONS IN INCHES MAXIMUM			
		"L" LENGTH INCHES	"W" WIDTH INCHES	"T" THICKNESS INCHES	LEAD SIZE AWG.
.10	708B1IE104P*101AX	.625	.310	.190	22
.15	IH154	.625	.355	.230	22
.22	IL224	.625	.400	.280	22
.33	NI334	.750	.365	.240	22
.47	NM474	.750	.425	.295	22
.68	VN684	.875	.450	.300	22
1.0	VT105	.875	.505	.350	20
1.5	VB155	.875	.610	.420	20
2.0	AY205	1.062	.585	.400	20
3.0	IA305	1.312	.600	.415	20
4.0	II 405	1.312	.685	.500	20
5.0	QB505	1.562	.790	.420	20
10.0	BN106	1.875	.930	.560	20

4

Film Capacitors

OUTLINE DRAWING



Lead Length 1.63" Min Both Sides

TYPICAL MARKING EXAMPLE	
Philips Components Voltage (DC)	100V
Type	708B1
Capacitance & Tol.	.10 ±10%
Date Code (Yr & Wk)	8640

200VDC AT 85°C					
CAP VALUE UF	PHILIPS COMPONENTS PART NUMBER*	DIMENSIONS IN INCHES MAXIMUM			
		"L" LENGTH INCHES	"W" WIDTH INCHES	"T" THICKNESS INCHES	LEAD SIZE AWG.
.10	708B1LJ104P*201AX	.710	.375	.250	22
.15	RI154	.840	.375	.240	22
.22	RN224	.840	.430	.300	20
.33	RU334	.840	.475	.360	20
.47	BQ474	1.09	.460	.320	20
.68	BY684	1.09	.540	.400	20
1.0	BE105	1.09	.660	.460	20
1.5	RY155	1.59	.600	.400	20
2.0	RH205	1.59	.680	.490	20
3.0	RL305	1.59	.880	.540	20
4.0	RT405	1.59	.975	.630	20
5.0	ZV505	1.84	1.00	.640	20
10.0	HG106	2.062	1.225	.850	20

*TOLERANCE: J = ±5%, K = ±10% STANDARD

NOTICE: MISAPPLICATION SUCH AS EXCEEDING DESIGN LIMITS MAY RESULT IN DESTRUCTION OR EXPLOSION OF CAPACITORS.

SERIES 719B1 (TYPE MKC)

Metalized Polycarbonate Capacitors (Philips 2222-344 Series)

DESCRIPTION

Nugget Series 719B1 metalized polycarbonate dielectric encased in a rectangular epoxy-encapsulated flame retardant polypropylene case with sturdy solder coated terminal pins, they lend themselves readily to insertion into printed circuit cards, motherboards and similar modular assemblies.

FEATURES

Electrical

- Rated capacitance range .01 to 6.8 μf
- Tolerance on rated capacitance $\pm$10%, $\pm$5%
- Climatic category 55/100/56
- Related specification IEC 384-6
- Dielectric Withstanding—160% x rated (VDC) terminal to terminal
  200% x rated VDC between interconnected terminals & case
- Dissipation Factor

capacitance	tangent of loss angle		
	1kHz	10 kHz	100 kHz
$C_R \leq 0{,}1\ \mu F$	$\leq 30 \times 10^{-4}$	$\leq 60 \times 10^{-4}$	$\leq 130 \times 10^{-4}$
$0{,}1\ \mu F < C_R \leq 1\ \mu F$	$\leq 30 \times 10^{-4}$	$\leq 60 \times 10^{-4}$	
$C_R > 1\ \mu F$	$< 30 \times 10^{-4}$	$\leq 75 \times 10^{-4}$	

- Insulation resistance

The insulation resistance is measured after a voltage has been applied for 1 min $\pm$5 s, the voltage being 100 $\pm$ 15V for the 100V, 250V and 400V versions, and 500 $\pm$50V for the 630V version, at $T_{amb} = 20°C$.

R between terminations, for $C_R \leq 0{,}33\ \mu F$
- 100V version $>$15,000 MΩ
- 250V, 400V, 630V versions $>$30,000 MΩ

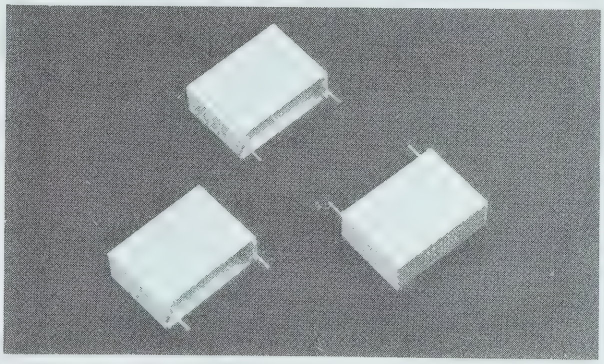
RC between terminations, for $C_R > 0{,}33\ \mu F$
- 100V version $>$5,000 s
- 250V, 400V, 630V versions $>$10,000 s

R between interconnected terminations and case (foil method) $>$30,000 MΩ

- Maximum pulse load

rated voltage V	maximum pulse load (V/μs)			
	L = 13 mm	L = 17,5 mm	L – 26 mm	L – 31 mm
100	30	13	6	4,5
250	45	18	8	7
400	70	30	13	11
630	100	45	18	15

The maximum pulse load values in the table are valid for pulse voltage equal to the rated voltage.



For lower pulse voltages the given values may be multiplied by U_R/applied voltage.

Note
If the pulse load requirement is satisfied, a check must be made to ascertain that the maximum dissipation is not exceeded.

- Standard Voltage Ratings—100, 250, 400 & 630 VDC @ +85°C
  63VAC, 160VAC, 220VAC @70°C
- Storage Temperature −55°C to +100°C

Mechanical

- Low cost
- Precision dimensioned case—permits high package density
- Mounting feet
- Self-healing
- Low dissipation factor
- High capacitance stability with temperature
- Resistance to soldering heat with preheating capacitors mounted on a 1.6 mm board with non-plated holes
  Body Temp.: 80°C
  Bath Temp.: 260°C
  Dwell Time: 5 s

HOW TO SPECIFY

Series 719B1 Capacitors may be specified using the following designation:
(See General Part Number Description for more details)

719B1 GD 104P K 251 S B

- 719B1 — **Series**
- GD — **Case Size**
- 104P — **Capacitance in (pF)**: In this example first two digits represent significant figures and last digit indicates the number of zeros to follow. P = Place Holder
- K — **Tolerance**: J = 5%, K = 10% STANDARD
- 251 — **Voltage at 85°C**: 101 = 100V, 251 = 250V, 401 = 400V, 631 = 630V
- S — **Specification**: S = Standard
- B — **Lead Configuration**

Straight Lead Code	Lead Spacing
A	0.394 (10mm)
B	0.591 (15mm)
D	0.886 (22.5mm)
E	1.08 (27.5mm)

SERIES 719B1

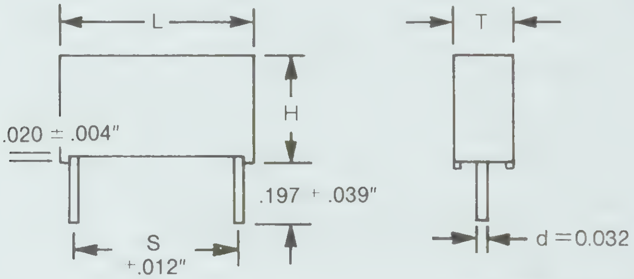
Metalized Polycarbonate Capacitors

719B1 Series

CAP VALUE UF	100VDC (63VAC RMS) PHILIPS COMPONENTS PART NUMBER	250VDC (160VAC RMS) PHILIPS COMPONENTS PART NUMBER	400VDC (220VAC RMS) PHILIPS COMPONENTS PART NUMBER	630VDC (220VAC RMS) PHILIPS COMPONENTS PART NUMBER
010	FOR THESE RATINGS USE THE CORRE-SPONDING HIGHER VOLTAGE LEVEL	FOR THESE RATINGS USE THE CORRE-SPONDING HIGHER VOLTAGE LEVEL	719B1CA103P*401SA	719B1CA103P*631SA
012			CA123	CB123
015			CA153	CB153
018			CA183	CC183
.022			CA223	CC223
027			CA273	719B1GE273P*631SB
033			CA333	GE333
039		719B1CA393P*251SA	719B1GD393P*401SB	GF393
047		CA473	GD473	GF473
056		CA563	GE563	GG563
068		CA683	GE683	GG683
082	719B1CA823P*101SA	719B1GD823P*251SB	GF823	719B1MH823P*631SD
10	CA104	GD104	GF104	MH104
12	CA124	GE124	GG124	MJ124
15	CA154	GE154	GG154	MJ154
18	CB184	GF184	719B1MH184P*401SD	ML184
22	CB224	GF224	MH224	ML224
27	719B1GD274P*101SB	GG274	MJ274	719B1RM274P*31SE
33	GD334	GG334	MJ334	RM334
39	GE394	719B1MH394P*251SD	ML394	RN394
47	GE474	MH474	ML474	RN474
56	GF564	MJ564	719B1RM564P*401SE	Not Available
68	GF684	MJ684	RM684	
82	GG824	ML824	RN824	
1 0	GG105	ML105	RN105	
1 2	719B1MH125P*101SD	719B1RM125P*251SE	Not Available	
1 5	MH155	RM155		
1 8	MK185	RN185		
2 2	MK225	RN225		
2 7	ML275	Not Available		
3 3	ML335			
3 9	719B1RM395P 101SE			
4 7	RM475			
5 6	RN565			
6 8	RN685			

* TOLERANCE: K = ± 10% (STD), J = ± 5%,

OUTLINE DRAWING



TYPICAL MARKING EXAMPLE

MARKING (TOP VIEW)
CAP UF/TOLERANCE/VOLTAGE WVDC
LAST EIGHT DIGITS OF CATALOG NUMBER
0.10/10/250
344/45104

CASE SIZE TABLE SERIES 719B1

CASE SIZE CODE	"L" LENGTH INCHES	"L" LENGTH mm	"H" HEIGHT INCHES	"H" HEIGHT mm	"T" THICKNESS INCHES	"T" THICKNESS mm	"S" SPACING INCHES	"S" SPACING mm	LEAD SIZE AWG
CA	.511	13	.394	10	.177	4.5	.394	10	20
CB	.511	13	.433	11	.197	5	.394	10	20
CC	.511	13	.472	12	.236	6	.394	10	20
GD	.689	17.5	.433	11	.197	5	.591	15	20
GE	.689	17.5	.472	12	.236	6	.591	15	20
GF	.689	17.5	.511	13	.276	7	.591	15	20
GG	.689	17.5	.571	14.5	.335	8.5	.591	15	20
MH	1.02	26	.610	15.5	.256	6.5	.886	22.5	20
MJ	1.02	26	.650	16.5	.295	7.5	.886	22.5	20
MK	1.02	26	.689	17.5	.335	8.5	.886	22.5	20
ML	1.02	26	.748	19	.374	9.5	.886	22.5	20
RM	1.22	31	.788	20	.433	11	1.08	27.5	20
RN	1.22	31	.886	22.5	.511	13	1.08	27.5	20
RG	1.22	31	.984	25	.591	15	1.08	27.5	20

DIMENSION IN INCHES (mm) MAXIMUM

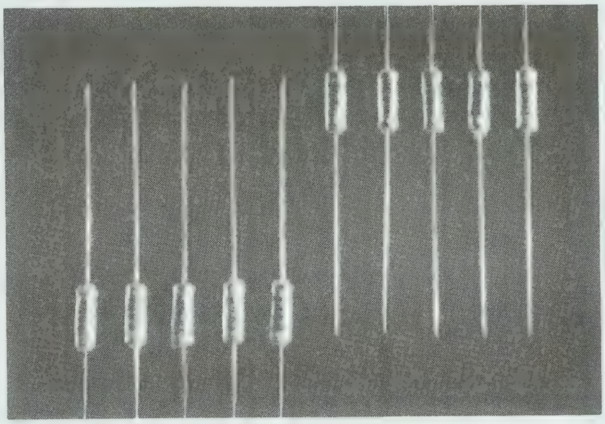
NOTICE: MISAPPLICATION SUCH AS EXCEEDING DESIGN LIMITS MAY RESULT IN DESTRUCTION OR EXPLOSION OF CAPACITORS.

AVAILABLE BULK ONLY

Philips Components • 6071 St. Andrews Road • Columbia, SC 29212-3198 • (803) 772-2500 • FAX: (803) 772-2445

SERIES 704C1 (Type KS)

Metalized Polycarbonate Capacitors (Philips 2222-341 Series)



DESCRIPTION

"Micro Poco" polystyrene and foil capacitors consist of low-inductive wound cells of metal foil with a polystyrene capacitor grade film. The cells are covered with a green plastic sleeve. The axial leads consist of solder coated wire.

FEATURES

Electrical

- Rated capacitance range 47 pF to 39,000 pF
- Tolerance on rated capacitance ±5%, ±2%, ±1%
- Climatic category
  63V-40/070/21 160V, 250V, 630V-40/085/21
- Related specification IEC 384-7
- Dielectric Withstanding—200% x Rated (VDC) terminal to terminal
  200% x rated VDC between interconnected terminals & case; min. 400V
- Dissipation Factor

capacitance	tangent of loss angle		
	at 1 kHz	at 100 kHz	at 1 MHz
$C_R \leq 1000$ pF	$\leq 5 \times 10^{-4}$		$\leq 10 \times 10^{-4}$
1000 pF $< C_R \leq 10000$ pF	$\leq 5 \times 10^{-4}$	$\leq 10 \times 10^{-4}$	
10000 pF $< C_R \leq 20000$ pF	$\leq 5 \times 10^{-4}$	$\leq 15 \times 10^{-4}$	
$C_R > 20000$ pF	$\leq 5 \times 10^{-4}$	$\leq 25 \times 10^{-4}$	

- Insulation Resistance >100,000MΩ (between terminations and terminations and case)
- Temperature Coefficients (PPM/°C) - (125±60) 10^{-6}/k
- Standard Voltage Ratings
  63VDC @−40°C to 70°C
  160VDC, 250VDC, 630VDC @ −40°C to +85°C

Mechanical

- Translucent sleeve to preserve marking legibility through the manufacturing process.
- Low self inductance
- Low series resistance
- High precision—±1%, ±2% tolerance
- Very small size
- Recommended for hand insertion only.
  Caution: Cleaning (open ends).
- Very high stability
- Precisely centered lead—making them compatible with automatic lead cutting and bending machine.
- Suitable for both point to point wiring and PC board insertion. Vertical and horizontal mount.
- Resistance to soldering heat with pre-heating capacitors mounted on a 1.6 mm board with non-plated holes.
  Body Temp.: 80°C
  Bath Temp.: 260°C
  Dwell Time: 5 s

HOW TO SPECIFY

Series 704C1 capacitors may be specified using the following designation:
(See General Part Number Description for more details)

704C1 FJ 103P F 251 A X

- 704C1 — Series
- FJ — Case Size
- 103P — Capacitance in (pF)
  In this example the first two digits represent significant figures and last digit indicates the number of zeros to follow.
  P = Place Holder
- F — Tolerance
  J = ±5%
  G=±2%
  F=±1%
- 251 — Voltage
  630= 63V(70°C)
  161=160V(85°C)
  251=250V(85°C)
  631=630V(85°C)
- A — Specification
  A=Standard
  T=Tape and Reel
- X — X=Axial Lead

Rating	Code
10PF	100
100PF	101
1000PF	102
.01UF	103

4

Film Capacitors

SERIES 704C1

Polystyrene & Foil Capacitors

TYPE 704C1

CAP VALUE UF	63VDC (25VAC RMS) @ 70°C PHILIPS COMPONENTS PART NUMBER*	63VDC MAX. DIMENSIONS "L" LENGTH	63VDC MAX. DIMENSIONS "D" DIAMETER	160VDC (63VAC RMS) @85°C PHILIPS COMPONENTS PART NUMBER*	160VDC MAX. DIMENSIONS "L" LENGTH	160VDC MAX. DIMENSIONS "D" DIAMETER	250VDC (125VAC RMS) @85°C PHILIPS COMPONENTS PART NUMBER*	250VDC MAX. DIMENSIONS "L" LENGTH	250VDC MAX. DIMENSIONS "D" DIAMETER	630VDC (250VAC RMS) @85°C PHILIPS COMPONENTS PART NUMBER*	630VDC MAX. DIMENSIONS "L" LENGTH	630VDC MAX. DIMENSIONS "D" DIAMETER
47PF										704C1AA410P*631AX	.433	.150
56PF										A560P	.433	.150
68PF										AA680	.433	.150
82PF							FOR THESE RATINGS USE THE CORRESPONDING HIGHER VOLTAGE LEVEL.			AA820	.433	.150
100PF				FOR THESE RATINGS USE THE CORRE–SPONDING HIGHER VOLTAGE LEVEL.						AA101	.433	.150
120PF										AA121	.433	.150
150PF	FOR THESE RATINGS USE THE CORRE-SPONDING HIGHER VOLTAGE LEVEL.									AA151	.433	.150
180PF										AA181	.433	.150
220PF										AA221	.433	.150
270PF										AA271	.433	.150
330PF										AB331	.433	.157
390PF										AB391	.433	.157
470PF										AC471	.433	.177
560PF							704C1AA561P*251AX	.433	.150	AC561	.433	.177
680PF							AA681	.433	.150	AC681	.433	.177
820PF							AB821	.433	.157	AC821	.433	.197
0010							AB102	433	.157	AD102	.433	.197
0012				704C1AB122P*161AX	.433	.157	AC122	.433	177	AD122	.433	.197
0015				AB152	.433	.157	AC152	433	.177	FD152	.591	.197
0018				AB182	433	157	AD182	.433	.197	FE182	.591	.217
0022	704C1AA222P*630AX	.433	.150	AC222	433	177	AD222	.433	197	FE222	.591	.217
.0027	AB272	.433	.157	AC272	433	177	FD272	591	.197	FF272	.591	.236
0033	AB332	.433	.157	AD332	433	197	FD332	.591	197	FG332	.591	.256
0039	AB392	433	.157	AD392	.433	.197	FD392	.591	.197	FH392	.591	.276
0047	AC472	.433	177	FD472	.591	197	FE472	.591	.217	FK472	.591	.315
0056	AC562	.433	.177	FD562	591	.197	FF562	.591	.236	FK562	.591	.315
0068	AD682	.433	.197	FE682	591	.217	FG682	591	.256			
0082	FD822	.591	197	FF822	.591	.236	FH822	591	276			
.010	FD103	591	.197	FF103	591	236	FJ103	591	296			
012	FE123	.591	.217	FG123	591	.256						
.015	FE153	591	.217	FH153	.591	276						
018	FF183	.591	.236									
.022	FG223	.591	.256									
.027	FH273	.591	.276									
.033	FJ333	591	.296	NOT AVAILABLE			NOT AVAILABLE			NOT AVAILABLE		
039	FK393	591	315									

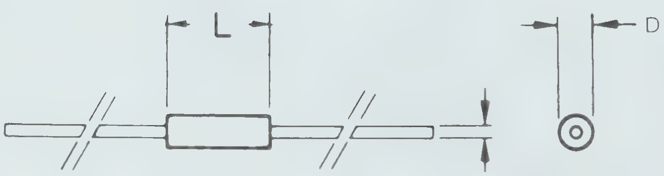
*INSERT APPROPRIATE LETTER INTO PART NUMBER
F=±1% (OR 1PF, WHICHEVER IS GREATER)
G=±2%
J=5%

NOTICE: MISAPPLICATION SUCH AS EXCEEDING DESIGN LIMITS MAY RESULT IN DESTRUCTION OR EXPLOSION OF CAPACITORS.

FOR CAPACITANCE RATINGS NOT LISTED REFER TO DECADE TABLE ON PAGE
±5% Tol. E24 SERIES
±2% Tol. E24, E48 SERIES
±1% Tol. E24, E48, E96 SERIES

AVAILABLE BULK OR TAPE & REEL.

OUTLINE DRAWING



Lead Length: 1.10 inch min. both sides

TYPICAL MARKING EXAMPLE

NOMINAL CAPACITANCE IN NANOFARADS OR PICOFARADS, ... 470
TOLERANCE, RATED VOLTAGE ...... F 63
FACTORY DATE CODE & CODE FOR DIELECTRIC MATERIAL N4KS

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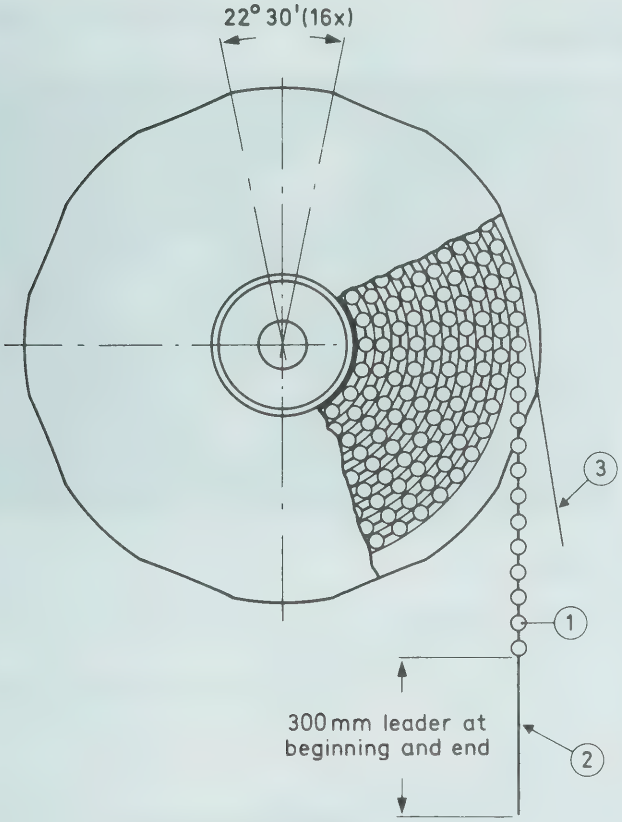
SERIES 704C1

Tape & Reel Packaging Specifications



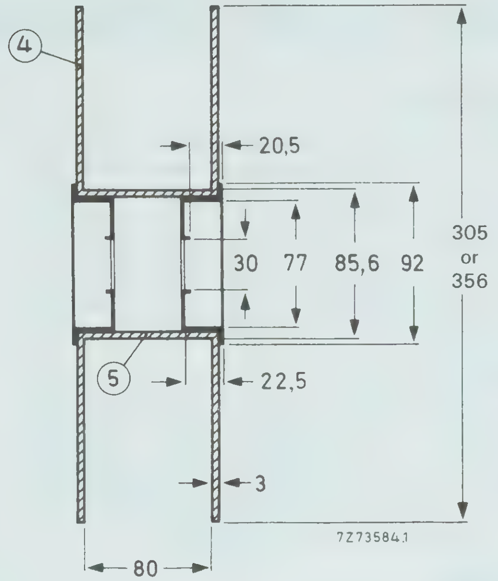
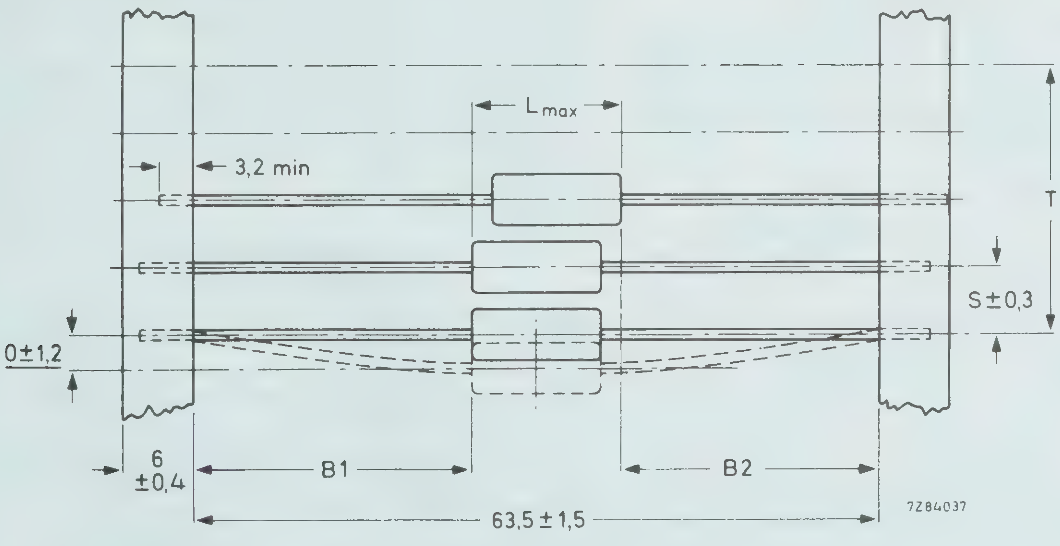


Fig. 11 Reel; for dimensions B see Table 9.
1: capacitor
2: bandolier
3: paper
4: flange
5: cylinder

Packing on bandoliers on reels

Dimensions in mm



704C1 Series

capacitance values (pF) of				S	T for number (n) of capacitors	
63 V version	160 V version	250 V version	630 V version		n < 50	50 < n < 100
2 000– 5 000	1 100–2 700	560– 1 500	51– 680	5	5(n-1)±2	5(n-1)±4
6 200–39 000	3 000–16 000	1 600–11 000	750–5 600	10	10(n-1)±2	10(n-1)±4

Characteristics concerning taped capacitors:

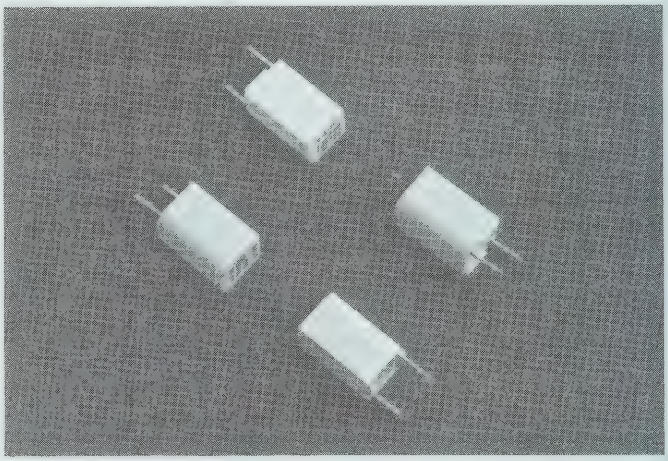
Pull-out force of the component	≥2 N
Tearing force of tape	≥10 N

Storage conditions:

Storage temperature range	−25 to +40°C
Relative humidity	≤80%

SERIES 719C1
(TYPE KS)

Polystyrene & Foil Capacitors (Philips 2222 443 Series)



4

Film Capacitors

DESCRIPTION

Series 719C1 polystyrene and foil capacitors consist of low-inductive wound cells of metal foil with polystyrene capacitor grade film. Encased in a rectangular epoxy encapsulated flame retardant polypropylene case with sturdy tinned solder coated pins. They lend themselves readily to insertion into printed circuit cards, mother boards, and similar modular assemblies.

APPLICATIONS

For use in LC filters, particularly in telephone equipment where high requirements are imposed on precision, stability, humidity, dissipation factor, and reliability. The dimensions are such that in combination with current available ferrites, a high package density is possible.

FEATURES

Electrical

- Rated capacitance range 100 to 34,000 pF
- Tolerance on rated capacitance ±1%
- Climatic category: Class 1 55/070/56
  Class 3 55/085/56
- Related specification IEC 384-7
- Dielectric Withstanding—200% x Rated (VDC) terminal to terminal.
  400 VDC between interconnected terminals & case (foil method).
- Dissipation Factor

capacitance	tangent of loss angle		
	at 1 kHz	at 100 kHz	at 1 MHz
$C_R \leq$ 500 pF	$\leq 5 \times 10^{-4}$		$\leq 5 \times 10^{-4}$
500 pF $< C_R \leq$ 1000 pF	$\leq 5 \times 10^{-4}$		$\leq 10 \times 10^{-4}$
1000 pF $< C_R \leq$ 10000 pF	$\leq 5 \times 10^{-4}$	$\leq 10 \times 10^{-4}$	
10000 pF $< C_R \leq$ 15000 pF	$\leq 5 \times 10^{-4}$	$\leq 15 \times 10^{-4}$	
15000 pF $< C_R \leq$ 20000 pF	$\leq 5 \times 10^{-4}$	$\leq 25 \times 10^{-4}$	
20000 pF $< C_R \leq$ 30000 pF	$\leq 5 \times 10^{-4}$	$\leq 40 \times 10^{-4}$	
$C_R >$ 30000 pF	$\leq 5 \times 10^{-4}$	$\leq 60 \times 10^{-4}$	

- Insulation resistance
  The insulation resistance is measured after a voltage of 10 ± 1V has been applied for 1 min ±5 s, at $T_{amb} = 20°C$.
  R between terminations >500000 MΩ
  R between interconnected terminations and case >500000 MΩ
- Temperature Coefficients (PPM/°C)
  $C_R \leq$ 15000PF $-(125 \pm 30) \times 10^{-6}$/K
  C > 15000PF $-(160 \pm 40) \times 10^{-6}$/K
- Standard Voltage Ratings—
  Class 1 (Stability Class) 63VDC @ −55°C to +70°C
  Class 3 (Stability Class) 63VDC @ −55°C to +85°C

Mechanical

- Low inductance
- Low series resistance
- High precision ±1% tolerance
- Precisely dimensioned case—Permits high package density.
- Mounting feet
- Flame retardant
- Withstand most solvent and rinsing liquids
- Lead solderability—Tested in accordance with MIL-STD-202, Method 208.
- Resistance to soldering heat with pre-heating capacitors mounted on a 1.6 mm board with non-plated holes.
  Body Temp.: 80°C
  Bath Temp.: 260°C
  Dwell Time: 5 s

TYPICAL MARKING EXAMPLE
CASE SIZE "CA" (FIGURE 1)

LINE 1: CAPACITANCE IN PF WITHOUT PF UNIT SYMBOL
LINE 2: TOLERANCE CODE (F=±1%); RATED VOLTAGE VDC
LINE 3: PRODUCTION DATE CODE; DIELECTRIC CODE (POLYSTYRENE=KS)

OUTSIDE FOIL (EARTH SIDE) IS INDICATED BY A VERTICAL LINE TO LEFT OF 2ND AND 3RD LINE OF MARKING AND BY THE BEVELLED CORNER.

CASE SIZES "CB" & "CC"
LINE 1: CAPACITANCE IN PF WITHOUT PF UNIT SYMBOL
LINE 2: TOLERANCE CODE (F=±1%), RATED VOLTAGE VDC
LINE 3: PHILIPS TYPE NO. 443
LINE 4: PRODUCTION DATE CODE; DIELECTRIC CODE (POLYSTYRENE = KS)

CASE SIZE "CA"

412P
F 63
KO KS

CASE SIZES "CB" & "CC"

412P
F 63
443
KO KS

SERIES 719C1
Polystyrene & Foil Capacitors

HOW TO SPECIFY:

Series 719C1 capacitors may be specified using the following designation:
(See General Part Number Description for more details)

719C1	CB	103P	F	630	S	G
Series	Case Size	Capacitance in (pF)	Tolerance F=±1%	Voltage at 85°C 630=63V	Specification S=Standard	Lead Configuration

Capacitance in (pF): In this example the first two digits represent significant figures and last digit indicates the number of zeros to follow. P = Place Holder

Lead Configuration

Straight Lead Code	Case Size
F	"CA"
G	"CB"
H	"CC"

AVAILABLE BULK ONLY.

719C1 SERIES, CAPACITANCE VALUES AVAILABLE (IN PF)

100	178	316	562	1000	1780	3160	5760	10200	18200
102	182	324	576	1020	1820	3240	5900	10500	18700
105	187	332	590	1050	1870	3320	6040	10700	19100
107	191	340	604	1070	1910	3400	6190	11000	20000
110	196	348	619	1100	1960	3480	6340	11300	21000
113	200	357	634	1130	2000	3570	6490	11500	21500
115	205	365	649	1150	2050	3650	6650	11800	22100
118	210	374	665	1180	2100	3740	6810	12100	22600
121	215	383	681	1210	2150	3830	6980	12400	23200
124	221	392	698	1240	2210	3920	7150	12700	23700
127	226	402	715	1270	2260	4120	7320	13000	24300
130	232	412	732	1300	2320	4220	7500	13300	24900
133	237	422	750	1330	2370	4320	7680	13700	25500
137	243	432	768	1370	2430	4420	7870	14000	26100
140	249	442	787	1400	2490	4530	8060	14300	27400
143	255	453	806	1430	2550	4640	8250	14700	28000
147	261	464	825	1470	2610	4750	8450	15000	28700
150	267	475	845	1500	2670	4870	8660	15400	29400
154	274	487	866	1540	2740	4990	8870	15800	30100
158	280	499	887	1580	2800	5110	9090	16200	30900
162	287	511	909	1620	2870	5230	9310	16500	31600
165	294	523	931	1650	2940	5360	9530	16900	32400
169	301	536	953	1690	3010	5490	9760	17400	33200
174	309	549	976	1740	3090	5620	10000	17800	34000

Mounting
The capacitors are designed for mounting on printed-wiring boards. The required space on the printed-wiring board for a hole diameter of 1 mm is given in Figs 4, 5 and 6.

Mechanical Data

63 VDC-25 VAC RMS (±1% TOLERANCE ONLY)
FOR CAPACITANCE VALUES AVAILABLE SEE NOTE ABOVE

CASE SIZE "CA"

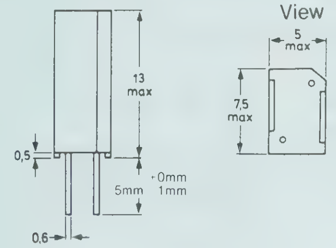


Fig. 1 Capacitors of rated capacitance range 100 to 3920 pF.

CASE SIZE "CB"

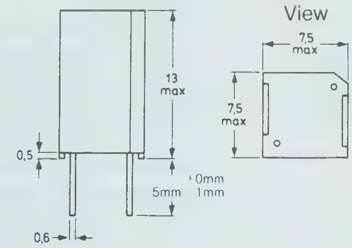


Fig. 2 Capacitors of rated capacitance range 100 to 15000 pF.

CASE SIZE "CC"

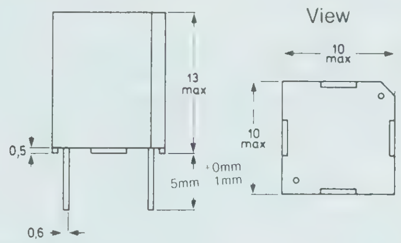


Fig. 3 Capacitors of rated capacitange range 15400 to 34000 pF.

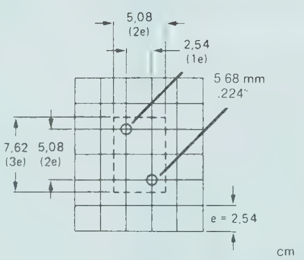


Fig. 4 Required space for capacitors according to Fig. 1.

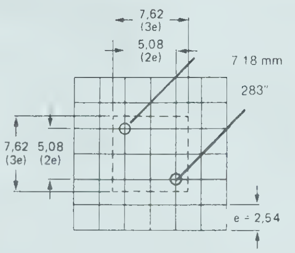


Fig. 5 Required space for capacitors according to Fig. 2.

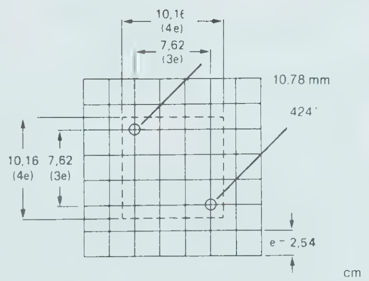


Fig. 6 Required space for capacitors according to Fig. 3.

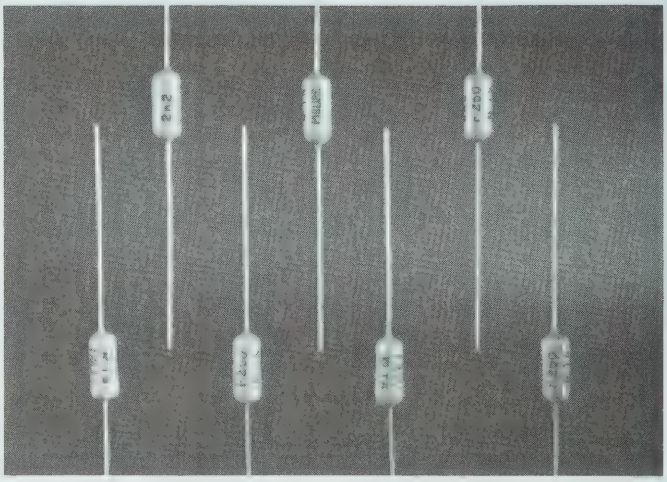
NOTICE: MISAPPLICATION SUCH AS EXCEEDING DESIGN LIMITS MAY RESULT IN DESTRUCTION OR EXPLOSION OF CAPACITORS.

4

Film Capacitors

SERIES 703E1 (TYPE KP)

Polypropylene Film & Foil Conformal Coated Capacitors (Philips 2222-460 Thru 464 Series)



DESCRIPTION

Polypropylene and foil capacitors consist of low inductive wound cells of metal foil and a polypropylene film. The cell is protected by a hard, non-flammable water repellant, solvent resistant, blue epoxy coating. The long axial leads of solder-coated wire make the capacitors suitable for vertical or horizontal mounting on printed-wiring boards.

APPLICATION

For use in circuits where precision, reliability and low losses are of prime importance, i.e., Tuned Circuits, Filter Networks, Timing Networks, etc.

FEATURES

Electrical

- Climatic category 40/100/56.
- Related specification IEC 384-13.
- Dielectric Withstanding—200% x Rated (VDC) terminals to terminals.
  200% x rated VDC between interconnected terminals and case, min. 400V.
- Dissipation Factor

capacitance	tangent of loss angle		
	at 1KHz	at 100KHz	at 1MHz
$C_R \leq$ 1000 pF	$< 5 \times 10^{-4}$		$< 10 \times 10^{-4}$*
1000 pF $< C_R \leq$ 5000 pF	$\leq 5 \times 10^{-4}$	$< 10 \times 10^{-4}$	*Single ended
5000 pF $< C_R \leq$ 20000 pF	$< 5 \times 10^{-4}$	$< 15 \times 10^{-4}$	$\leq 13 \times 10^{-4}$
20000 pF $< C_R \leq$ 47000 pF	$\leq 5 \times 10^{-4}$	$\leq 25 \times 10^{-4}$	
$C_R >$ 47000 pF	$\leq 5 \times 10^{-4}$	$\leq 40 \times 10^{-4}$	

- Insulation Resistance
  The insulation resistance is measured after a voltage has been applied for 1 min ± 5 s, the voltage being 10 ± 1V for the 63V version, 100 ± 15V for the 160V and 250V versions.
  R between terminations >100000 MΩ
  R between interconnected terminations and case >100000 MΩ
- Temperature coefficient
  between −40 and +20°C
  for 400V-630V −(125±125) 10^{-6}/K
  for 63V-160V-250V −(125±60) 10^{-6}/K
  between +20 and +100°C −(250±120) 10^{-6}/K
- Standard Voltage Ratings
  63, 160, 250, 400, & 630 VDC @ +85°C
  40, 63, 125, 160, & 200 VAC (RMS)
- Capacitance Range (Available) 47 to 62,000 pf
  ±5%+E24 DECADE
  ±2%−E24 & E48 DECADE
  ±1%−E24, E48, E96 DECADE**
- Tolerance On Rated Capacitance:
  ±5%, ±2% or 2 pF whichever is greater.

Mechanical

- Low series resistance
- Low self inductance
- Very small size
- Precision tolerance
- Precisely centered lead making them compatible with automatic lead cutting and bending machines.
- Suitable for both point to point wiring and PC board insertion.
- Lead solderability—Tested in accordance with MIL-STD-202, Method 208.
- Resistance to soldering heat with pre-heating: capacitors mounted on a 1.6 mm board with non-plated holes.
  Body Temp.: 80°C
  Bath Temp.: 260°C
  Dwell Time: 5 s
- Storage Temperature Range −25°C to +40°C @ ≤ 80 % RH

HOW TO SPECIFY

Series 703E1 Capacitors may be specified using the following designation: (See General Part Number Description for more details)

703E1 FE 103P G 161 A X

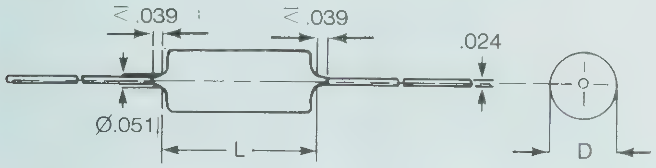
- **703E1** — **Series**
- **FE** — **Case Code**
- **103P** — **Capacitance in (pF)**: In this example the first two digits represent significant figures and last digit indicates the number of zeros to follow. P = Place Holder
- **G** — **Tolerance**: J=±5%, G=±2%, **F=±1%
- **161** — **Voltage at 85°C**: 630= 63V, 161=160V, 251=250V, 401=400V, 631=630V
- **A** — **Specification**: A = Standard, T = Tape & Reel, S = Single-ended (Radial) Tape & Reel
- **X** — X = Axial Lead

**See Statement on 1% Tolerance.

SERIES 703E1

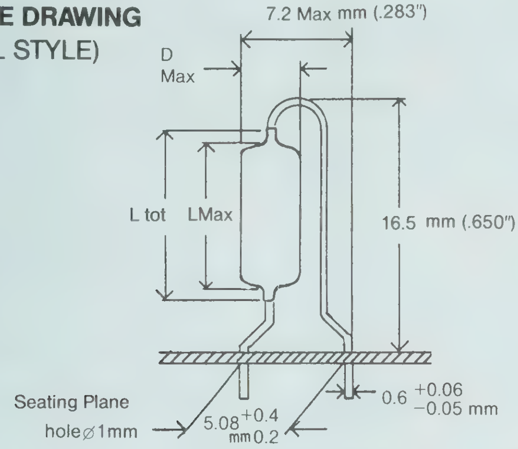
Polystyrene & Foil Conformal Coated Capacitors

OUTLINE DRAWING *For clean lead to clean lead due to conformal coating Case A is .512" max and Case F is .670" max.
(AXIAL STYLE)



Lead Length: 1.10" (28mm) Min. Both Sides

OUTLINE DRAWING
(RADIAL STYLE)



CASE SIZE TABLE

CASE SIZE CODE	"L" LENGTH* INCHES	"L" LENGTH* MM	"D" DIAMETER INCHES	"D" DIAMETER MM
AD	.433	11.0	.197	5.0
FE	.591	15.0	.217	5.5
FF	.591	15.0	.236	6.0
FG	.591	15.0	.256	6.5
FH	.591	15.0	.276	7.0
FJ	.591	15.0	.296	7.5
FK	.591	15.0	.315	8.0

(DIMENSIONS IN INCHES (MM) MAXIMUM)

TYPICAL MARKING EXAMPLE	
Nominal Capacitance (NF or PF)	10n
Tolerance Code & Rated D.C. Voltage (without symbol)	G 160
Dielectric Code & Date Code	KP 9
Name of Manufacturer	Philips

**1% tolerance units available. However, ΔC may be as much as 1.25% on parts shipped.

CAP VALUE UF	63VDC (40VAC) PHILIPS COMPONENTS PART NUMBER*	160VDC (63VAC) PHILIPS COMPONENTS PART NUMBER*	250VDC (125VAC) PHILIPS COMPONENTS PART NUMBER*	400VDC (160VAC) PHILIPS COMPONENTS PART NUMBER*	630VDC (200VAC) PHILIPS COMPONENTS PART NUMBER*
47PF					703E1AD470P*631AX
56PF					AD560
68PF					AD680
82PF					AD820
100PF			FOR THESE RATINGS USE THE CORRESPONDING HIGHER VOLTAGE LEVEL		AD101
120PF	FOR THESE RATINGS, USE THE CORRESPONDING HIGHER VOLTAGE LEVEL				AD121
150PF				703E1AD151P*401AX	
180PF				AD181	
220PF				AD221	
270PF				AD271	
330PF				AD331	
390PF				AD391	
470PF				AD471	
560PF				AD561	
680PF				AD681	
820PF				AD821	
.0010				AD102	
.0012			703E1AD122P*251AX		
.0015			AD152		
.0018			AD182		
.0022			AD222		
.0027			AD272		
.0033			AD332		
.0039		703E1AD392P*161AX	FE392		
.0047		AD472	FE472		
.0056		AD562	FE562		
.0068	703E1AD682P*630AX	FE682	FE682		
.0082	AD822	FE822	FE822		
.010	FE103	FE103	FF103		
.012	FE123	FE123	FG123		
.015	FE153	FE153	FH153		
.018	FE183	FF183	FJ183		
.022	FE223	FG223	FK223		
.027	FF273	FH273			
.033	FG333	FJ333			
.039	FH393	FK393			
.047	FJ473				
.056	FK563	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE
.062	FK623				

CAPACITANCE TOLERANCE
J=±5%
G=±2%
F=±1%**

NOTICE: Misapplication such as exceeding design limits may result in destruction or explosion of capacitors.

STRAIGHT AXIAL LEADS AVAILABLE BULK OR ON TAPE & REEL. RADIAL LEADS TAPE & REEL ONLY.

4 *Film Capacitors*

SERIES 703E1

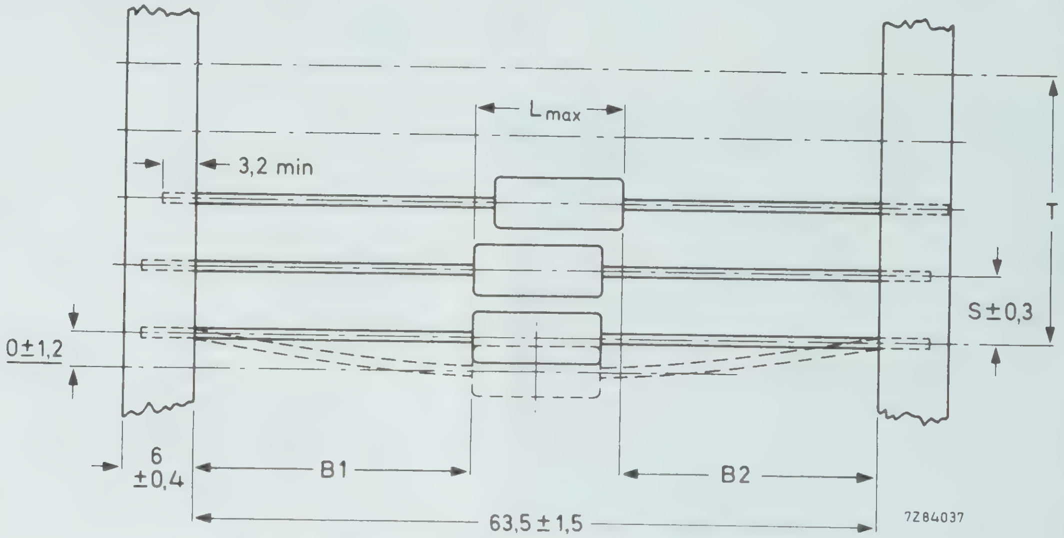
Tape & Reel Specifications (Axial)

4

Film Capacitors

Packing on bandoliers on reels

Dimensions in mm



Capacitors on bandoliers; for dimensions S and T, see Table
|B1-B2| = max. 1,4 mm; for dimension L_{max}, see size table.

capacitance values (pF) of			S	T for number (n) of capacitors	
63 V version	160 V version	250/400/630 V version		n < 50	50 < n < 100
6 800– 9 100	3 600– 6 200	47– 3 300	5	5(n-1)±2	5(n-1)±4
10 000–62 000	6 800–39 000	3 600–22 000	10	10(n-1)±2	10(n-1)±4

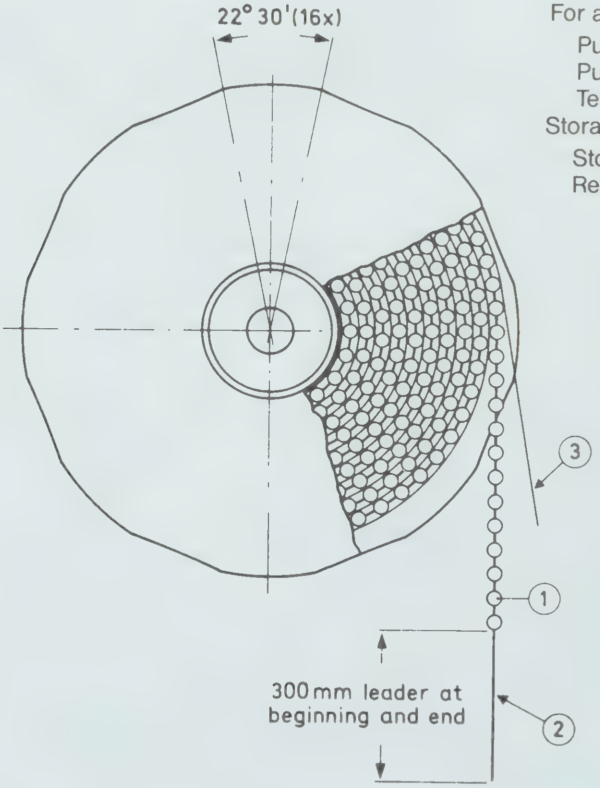
Characteristics concerning taped products

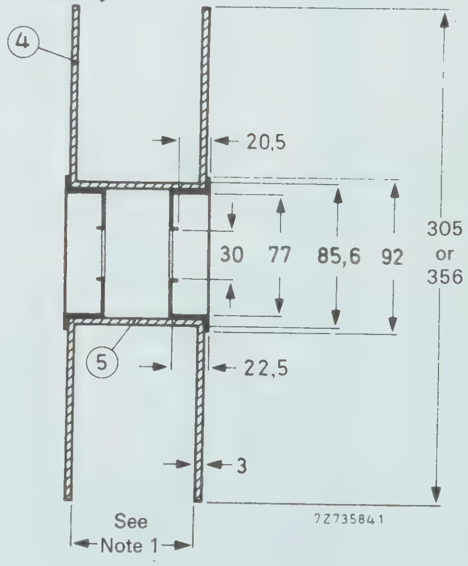
For axial leads

Pull-out force of the component	≥2 N
Pull-off force of adhesive tape	≥6 N
Tearing force of tape	≥15 N

Storage conditions

Storage temperature range	−25°C to +40°C
Relative humidity	≤80%



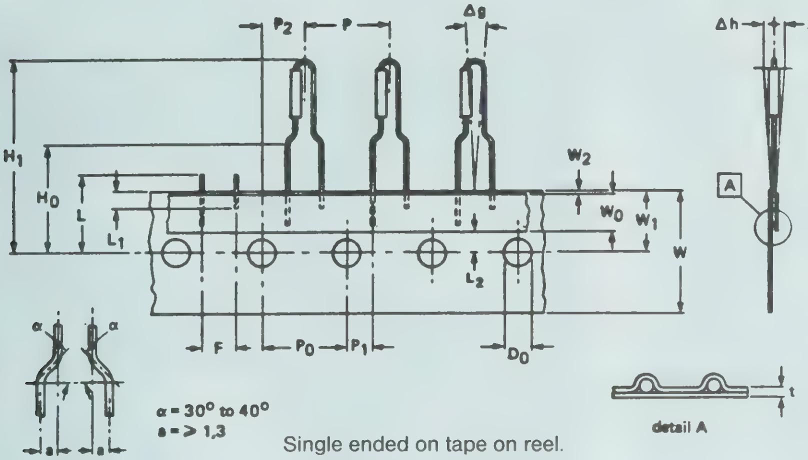


Note 1—axial lead 80 mm/radial lead 52 mm

1: capacitor
2: bandolier
3: paper
4: flange
5: cylinder

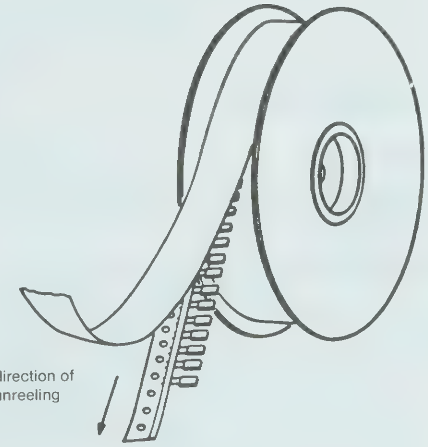
SERIES 703E1

Tape & Reel Specifications (Radial)



Single ended on tape on reel.

Pitch of components	P		12,7±1,0
Feed hole pitch	P_0		12,7±0,2
Cumulative pitch error	T		1,0 per 20 spacings
			0,5 per 4 spacings
Feed hole centre to lead at topside at the tape	P_1		3,85±0,5
Feed hole centre to body centre	P_2		6,35±1,0
Lead to lead distance	F		5,08 +0,4 −0,2
Component alignment	Δh		0±1,2
Component alignment	Δp		±1,0
Tape width	W		18,0±0,5
Hold down tape width	W_0	min.	5,5
Hole position	W_1		9,0±0,5
Hold down tape position	W_2	max.	0,5
Lead wire clinch height	H_0		16,0±0,5
Component height	H_1	max.	32
Feed hole diameter	D_0		4,0±0,2
Total tape thickness	t		0,7±0,2
Length of snipped lead	L	max.	11,0
Lead wire (tape portion) shortest lead	L_1	min.	2,0
Lead wire protrusion	L_2	max.	4



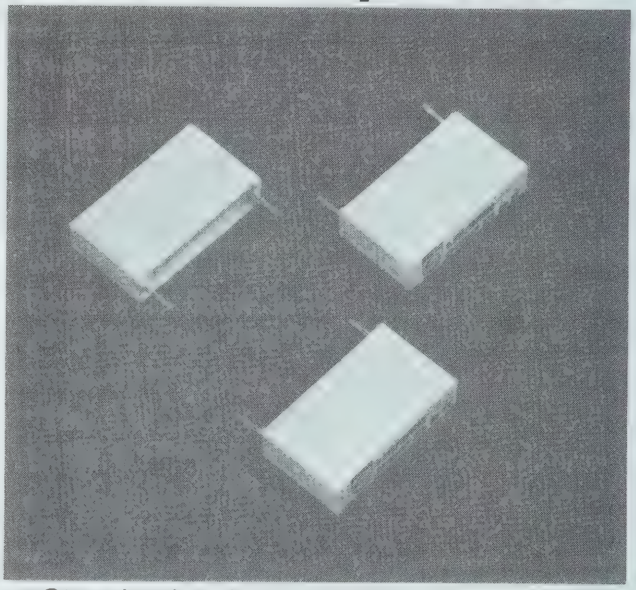
Reel for single ended version.

For radial leads

Pull-out force of the component	≥5 N
Pull-off force of adhesive tape	≥6 N
Tearing force of tape	≥15 N

SERIES 719F1 (TYPE KP/MMKP)

Polypropylene Series Construction Capacitors (Philips 2222-376 Series)



DESCRIPTION

The capacitors consist of a series-constructed, low-inductance wound cell of polypropylene film, aluminum foil and double metallized polyester film. The cell is potted with epoxy resin in a flame retardent polypropylene case. The radial leads are of solder-coated wire. The capacitors can withstand solvents and rinsing liquids without damage. They are provided with small stand-off pips to allow removal of solder flux etc., when cleaning the printed-wiring board.

4

Film Capacitors

APPLICATION

These capacitors are for applications where high currents and steep pulses occur. They are mainly used for deflection circuits in television receivers, to operate at high peak currents at line frequency.

FEATURES

Electrical

- Rated Capacitance Range (E12, E24 Series) .001μF to 0.27μF
- Climatic Category 55/100/56
- Related Specification IEC 384-17
- Dielectric withstanding—160% x rated (VDC) terminal to terminal. 2840 VDC between interconnected terminations and case.
- Dissipation Factor

Rated voltage	Dissipation factor @ 25°C @ 100 KHZ		
V	L=17.5 mm	L=265 mm	L-31 mm
630	$\leq 10 \times 10^{-4}$	$\leq 15 \times 10^{-4}$	$< 20 \times 10^{-4}$
1000	$\leq 10 \times 10^{-4}$	$\leq 10 \times 10^{-4}$	$\leq 15 \times 10^{-4}$
1600	$\leq 10 \times 10^{-4}$	$\leq 10 \times 10^{-4}$	$\leq 15 \times 10^{-4}$
2000	$\leq 10 \times 10^{-4}$	$\leq 10 \times 10^{-4}$	$< 15 \times 10^{-4}$

- Insulation resistance
  The insulation resistance is measured after a voltage of 500 ±50 V has been applied for 1 min.±5 s, at T_{amb}=23°C.
  R between terminations >100000 MΩ
  R between interconnected terminations and case >100000 MΩ
- Standard voltage (DC) ratings 630V, 1000V, 1600V, 2000V @ +85°C
  AC @ 60HZ, 300V, 400V, 500V, 600V @+70°C

Mechanical

- Low cost—Available Bulk
- Precisely dimensioned case-permits high density
- Mounting feet
- Flame retardant
- Lead solderability—Tested in accordance with MIL-STD-202 method 208
- Withstand most solvent and rinsing liquids
- Storage conditions—−25°C to +40°C RH max 80% w/o condensation

HOW TO SPECIFY

Series 719F1 capacitors may be specified using the following designation:
(See General Part Number Description for more details)

719F1 RP 104P K 631 S E

Series — 719F1

Case Size — RP

Capacitance in (pF) — 104P
In this example the first two digits represent significant figures and last digit indicates the number of zeros to follow.
P = Place Holder

Tolerance — K
J=± 5%
K=±10%
W=±3.5%
(Special)

Voltage @ 85°C — 631
630VDC = 631
1000VDC = 102
1600VDC = 162
*2000VDC = 202

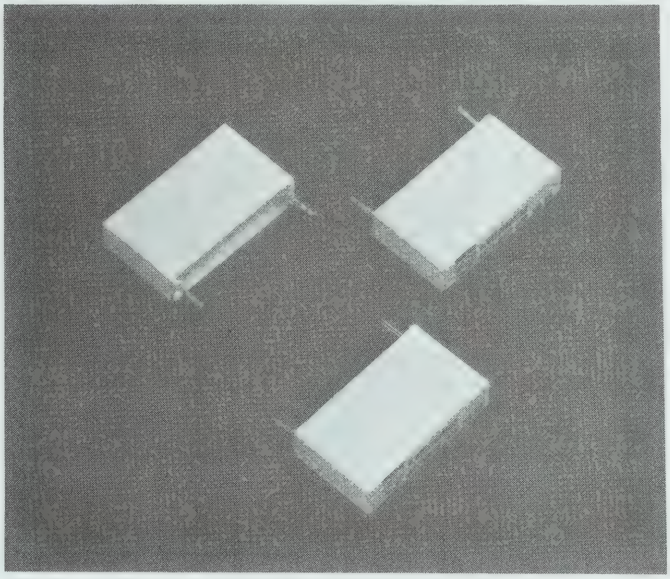
*±5% Tol. Only

Specification — S
S = standard

Lead Configuratio — E

Straight Lead Code	Lead Spacin
B	15/0.5
D	22.5/0.8
E	27.5/1.

Polypropylene Construction Capacitors (Philips 2222-378 Series)



DESCRIPTION

The capacitors consist of a low-inductance wound cell of metallized polypropylene film. The cell is potted with epoxy resin in a blue flame retardant polypropylene case. The radial leads are of solder-coated wire. The capacitors can withstand solvents and rinsing liquids without damage. They are provided with small stand-off pips to allow removal of solder flux etc., when cleaning the printed-wiring board.

APPLICATION

These capacitors are for applications where high currents at high frequencies, and steep pulses occur, or high stability is required. Their small dimensions make them suitable for circuits with high package density.

FEATURES

Electrical

- Rated Capacitance Range .0033 μF to 3.3 μF
- Climatic Category 55/085/56
- Related Specification IEC 384-17
- Dielectric withstanding—160% x rated (VDC) terminal to terminal. 2840 VDC between interconnected terminations and case.
- Dissipation Factor

rated voltage	Dissipation Factor @ 25°C			
	at 10 kHz		at 100 kHz	
DC	L = 26 mm	L = 31 mm	L = 26 mm	L = 31
250	≤ 15 x 10^{-4}	≤ 20 x 10^{-4}	≤ 70 x 10^{-4}	–
400	≤ 10 x 10^{-4}	≤ 15 x 10^{-4}	≤ 40 x 10^{-4}	≤ 50* x 10^{-4}
630	≤ 8 x 10^{-4}	≤ 10 x 10^{-4}	≤ 20 x 10^{-4}	≤ 30 x 10^{-4}
1000	≤ 6 x 10^{-4}	≤ 8 x 10^{-4}	≤ 15 x 10^{-4}	≤ 20 x 10^{-4}
1600	≤ 5 x 10^{-4}	≤ 6 x 10^{-4}	≤ 10 x 10^{-4}	≤ 15 x 10^{-4}
2000	≤ 5 x 10^{-4}	≤ 5 x 10^{-4}	≤ 10 x 10^{-4}	≤ 10 x 10^{-4}

Mechanical

- Low Cost—Available Bulk
- Precisely dimensioned case-permits high density
- Mounting feet
- Flame retardant

- Lead solderability—Tested in accordance with MIL-STD-202 method 208
- Insulation resistance
  The insulation resistance is measured after a voltage of 500 ±50 V has been applied for 1 min.±5 s, at T_{amb}=23°C.
  R between terminations >100000 MΩ
  R between interconnected terminations and case >100000 MΩ
- Standard voltage (DC) ratings 250V, 400V, 630V, 1000V, 1600V, 2000V @ +85°C
- AC @ 60HZ ratings 160V, 200V, 300V, 400V, 500V, 600V @ +70°C.

HOW TO SPECIFY

Series 719F1 capacitors may be specified using the following designation:
(See General Part Number Description for more details)

719F2 MG 104P K 631 S E

Series (719F2)

Case Size (MG)

Capacitance in (pF) (104P)
In this example the first two digits represent significant figures and last digit indicates the number of zeros to follow.
P = Place Holder

Tolerance (K)
J=±5%

Voltage @ 85°C (631)
250VDC = 251
400VDC = 401
630VDC = 631
1000VDC = 102
1600VDC = 162
2000VDC = 202

Specification (S)
S=standard
T=tape & reel @ 18 mm
D=tape & reel @ 16.5 mm

Lead Configuration (E)

Straight Lead Code	Lead Spacing
D	22.5/0.886
E	27.5/1.08

719F1 SERIES
719F2 SERIES

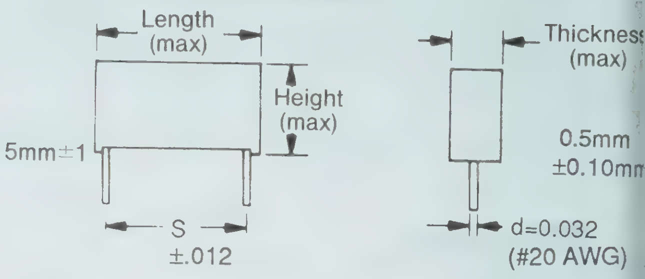
CAPACITANCE VS CASE SIZE

CAP VALUE MF	CAP CODE	719F1 630 DC	719F1 1000 DC	719F1 1600 DC	719F1 2000 DC	719F2 250 DC	719F2 400 DC	719F2 630 DC	719F2 1000 DC	719F2 1600 DC	719F2 2000 DC
.0010	102	NOT AVAILABLE			GD						
.0012	122				GE						
.0015	152				GE						
.0018	182			GD	GF			NOT AVAILABLE			
.0022	222			GE	GG						
.0027	272			GF	GG						
.0033	332			GF	MF						MF
.0039	392			GG	MF						MF
.0047	472		GD	GG	MG						MG
.0056	562		GD	MF	MK					MF	MG
.0068	682	GD	GE	MF	MK					MF	MK
.0082	822	GD	GE	MG	MK					MG	MK
.010	103	GE	GF	MK	MM					MG	MM
.012	123	GE	GG	MK	RP				MF	MK	MM
.015	153	GF	MG	MM	RP				MF	MK	RP
.018	183	GF	MG	RP	RR				MF	MM	
.022	223	GG	MK	RP	RR				MG	MM	
.027	273	MF	MK	RR	RG				MG	RP	
.033	333	MG	MK	RR	RH				MK	RP	
.039	393	MG	MM	RG					MK	RR	
.047	473	MK	RL	RG					MM	RR	
.056	563	MK	RP	RH				MF	RP	RG	
.068	683	RL	RP					MF	RP	RG	
.082	823	RP	RR					MG	RP	RH	
.10	104	RP	RR					MG	RR	RH	
.12	124	RR	RG					MK	RG		
.15	154	RR	RG					MK	RG		
.18	184	RG	RH				MF	MM	RH		
.22	224	RH					MG	RP	RH		
.27	274	RH					MK	RP			
.33	334					MG	MK	RR			
.39	394					MG	MM	RR			
.47	474					MG	MM	RG			
.56	564					MK	RP	RH			
.68	684					MM	RP	RH			
.82	824					MM	RR				
1.0	105		NOT AVAILABLE			RP	RR				
1.2	125					RP	RG				
1.5	155					RR	RH				
1.8	185					RR	RH				
2.0	205					RG	RH		NOT AVAILABLE		
2.2	225					RG					
2.7	275					RH					
3.0	305					RH					
3.3	335					RH					

CASE SIZE TABLE SERIES 719F1 & 719F2

CASE CODE	LENGTH (MAX) INCH	LENGTH (MAX) MM	HEIGHT (MAX) INCH	HEIGHT (MAX) MM	THICKNESS (MAX) INCH	THICKNESS (MAX) MM	LEAD SPACE (NOM) INCH	LEAD SPACE (NOM) MM
GD	.689	17.5	.433	11	.197	5	.591	15
GE	.689	17.5	.472	12	.236	6	.591	15
GF	.689	17.5	.512	13	.276	7	.591	15
GG	.689	17.5	.571	14.5	.335	8,5	.591	15
MF	1.02	26	.610	15.5	.236	6	.886	22.5
MG	1.02	26	.650	16.5	.276	7	.886	22.5
MK	1.02	26	.709	18	.335	8.5	.886	22.5
MM	1.02	26	.768	19.5	.394	10	.886	22.5
RG	1.22	31	.984	25	.591	15	1.08	27.5
RH	1.22	31	1.10	28	.709	18	1.08	27.5
RL	1.22	31	.748	19	.354	9	1.08	27.5
RP	1.22	31	.827	21	.433	11	1.08	27.5
RR	1.22	31	.906	23	.512	13	1.08	27.5

OUTLINE DRAWING



TYPICAL MARKING EXAMPLE

Top &/or Side

Nominal Cap (μF, PF, NF)/ Tol./Rated D.C. Voltage	24NK 630
Dielectric Code, Type Code, Manufacturer	876 61 KP/MMKP Philips 3942
Date Code (Yr/Wk)	

NOTE: Variation in label information possible depending on unit size & type.

Part Number Examples:

1. .01 MF ±10% 1600VDC (719F1 Series) = 719F1MK103PK162SD
   Straight Lead/22.5 mm Spacing
2. 1.5 MF ±5% 400VDC (719F2 Series)
   Tape & Reel @ 18 mm / 27.5 mm Spacing = 719F2RH155PJ401TE
3. Same as 2 Except Bulk = 719F2RH155PJ401SE

DC/AC Voltage Ratings						
VDC @ 85°C	250	400	630	1000	1600	2000
VAC @ 70°C	160	200	300	400	500	600

NOTICE: MISAPPLICATION SUCH AS EXCEEDING DESIGN LIMITS MAY RESULT IN DESTRUCTION OR EXPLOSION OF CAPACITORS.

SERIES 719F2 (TYPE MKP OR MKP/MKP)

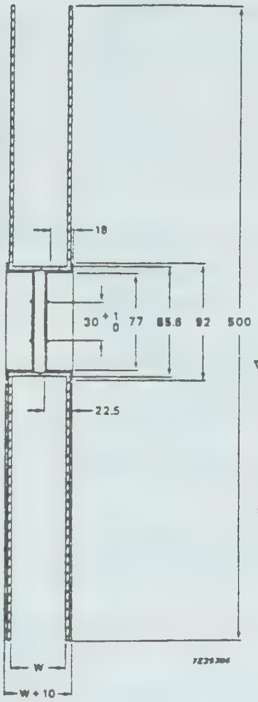
Tape & Reel Specifications (Radial)

NUMBER OF CAPACITORS PER REEL

T_{max} mm	Number per reel	Nominal reel width w ± 2 mm
6	600	56
7	500	56
8.5	450	56
10	350	61
11	300	61
13	250	61
15	200	66
18	150	66

maximum number of empty places per reel ̷ not exceed 0.5% of the total number of nponents per reel.

consecutive components may be missing vided that this gap is followed by six con- utive components.



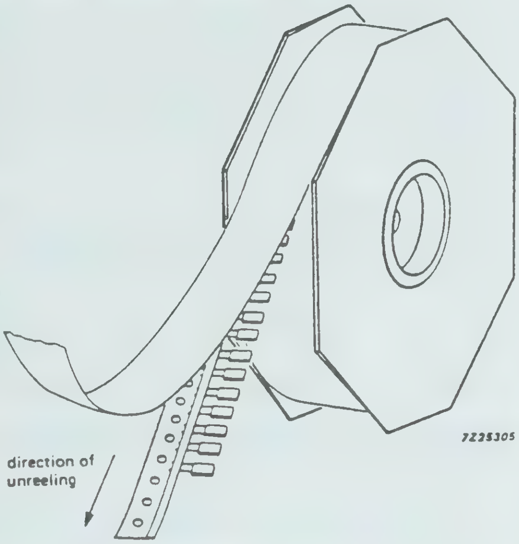
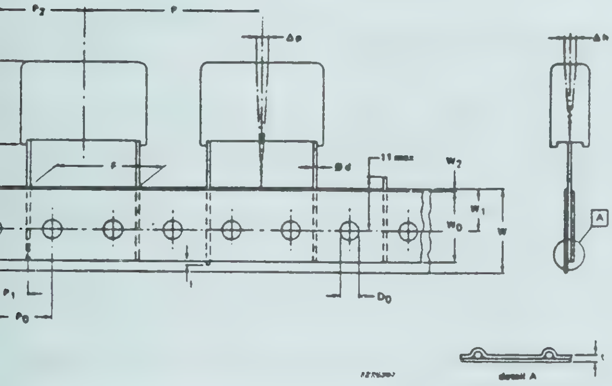


Fig. 3 Dimensions and view of reel.



TAPE & REEL

DESCRIPTION		MM
Center of lead to center of lead distance	F	22.5 +0.5 −0.1 27.5 +0.5 −0.1
Lead wire diameter	d	0.8 +0.08 −0.05
Distance between the longitude axis of the component	P	38.1 ± 1
Feed hole pitch*	P_O	12.7 ± 0.2
Feed hole center to lead center	P_1	7.8 ± 0.7 5.3 ± 0.7
Hole center to component center	P_2	19.5 ± 1
Component alignment	Δh ΔP	0 ± 2 0 ± 1.3
Tape width	W	18 ± 0.5
Hold down tape width	W_0	15 ± 0.5
Hole position	W_1	9 ± 0.5
Hold down tape position	W_2	0.5 −0 +1.5
Height of component from tape center	H_2	18 ± 2 (standard) 16.5 ± 0.5 (special)
Component height	H_1	40 max. 50 max.
Lead wire protrusion	1	0.5 min.
Feed hole diameter	D_0	4.0 ± 0.2
Total tape thickness	t	0.5 ± 0.2

*Error 1mm per 20 pitches

SERIES 719F1
SERIES 719F2

Part 1

719F1 & 719F2 Power Capacitors Design Section
This Design Section has been established in order for our customers to determine which capacitor is best suited for use in their particular application. By following these guidelines the designer can determine which capacitor type to use.

This section is a guide. If questions arise please contact a Philips Components sales office or the Film Capacitor facility direct at Columbia, S.C.

Part 1 General Application Informations
Part 2 719F1 Series (Philips 2222-376)
Part 3 719F2 Series (Philips 2222-378)

APPLICATION INFORMATION FOR 719F1 & 719F2 SERIES CAPACITORS
The following six constraints should be taken into consideration when selecting a capacitor for a given application:

1. The peak voltage (V_p) should not exceed the rated DC voltage.
2. The peak to peak voltage (V_{p-p}) should not be greater than $2.\sqrt{2}$ times the rated AC voltage to avoid the ionisation inception level.

3 (a). The peak current (I_p) should not exceed the maximum peak current, defined as maximum voltage pulse slope (dV/dt) multiplied by the capacitance:

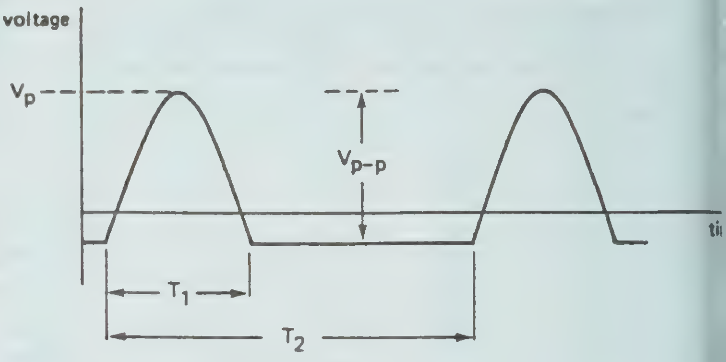
$$I_p \text{ max} = C\left(\frac{dV}{dt}\right) \text{max.}$$

or:

3 (b). The voltage pulse slope should not exceed the rated voltage pulse slope. Where the pulse voltage is lower than the rated voltage, the values in Table 9 may be multiplied by U_R/applied voltage.

4. The maximum power dissipation, as defined previously, must not be exceeded.
5. The free air temperature for the capacitor should not exceed the rated temperature.
6. As with all metallized film capacitors, there is an intrinsically active flammability risk. It is therefore recommended that these capacitors are only employed in circuits where in the event of failure of the capacitor, power to the capacitor is limited to less than 5 VA.

Example
A 10 nF, 1600 V capacitor selected for use with an applied voltage signal as shown in Fig. 17. In the event of capacitor failure, the power is switched off. The ambient temperature is 50°C.



V_{p-p} = 1200 V;
V_p = 1100 V;
T_1 = 12 μs;
T_2 = 64 μs.

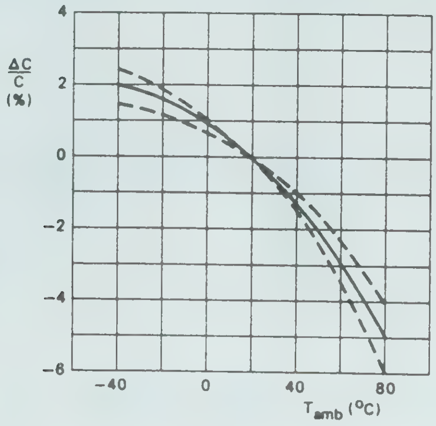
Fig. 17 Half-sinewave pulse.

Analysis

1. The peak voltage V_p of 1100 V is less than the rated 1600 VDC.
2. The peak to peak voltage of 1200 V is less than 500 VAC x $2.\sqrt{2}$ (= 1414 V_{p-p}).
3. The voltage pulse slope dV/dt: $\frac{2\pi}{24}$ 1200V/μs = 320 V/μs.
   This is lower than 1600 v/μs specified in Table 9.
4. The dissipated power is 180 mW as calculated with Fourier terms. This is less than the 320 mW allowed for a capacitor with dimensions of 7,0 x 16,5 x 26 mm as shown in Fig. 15.
5. The free air ambient temperature is 50°C, which is below the 70°C maximum figure.
6. In the event of failure of the capacitor, the power is limited to 0 VA.

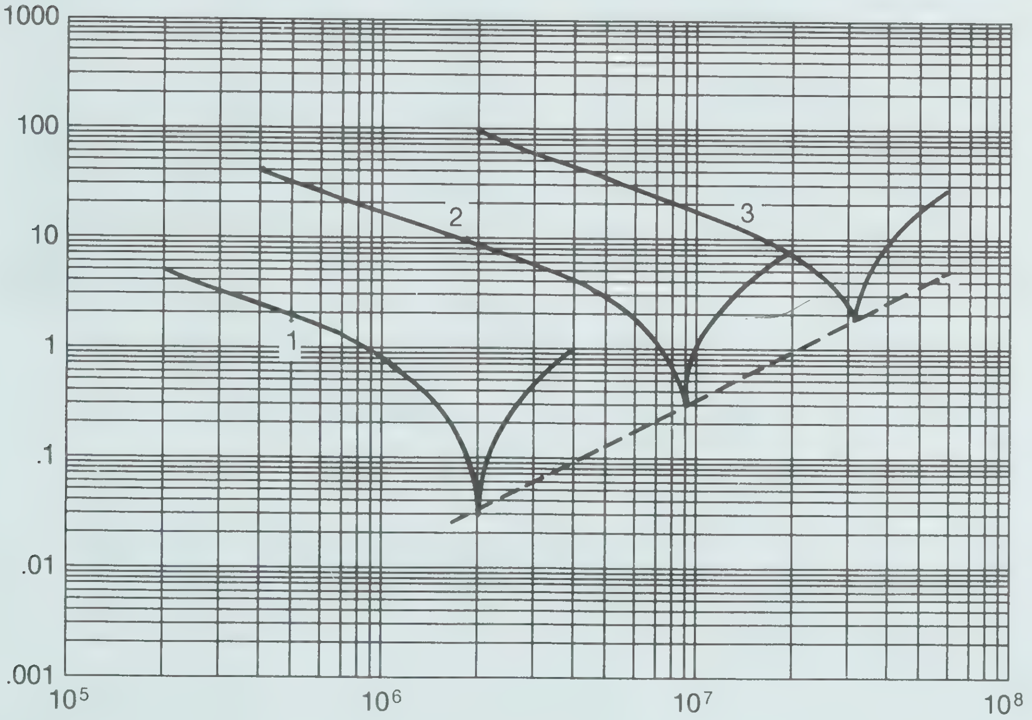
Part 2

I. CAPACITANCE



Capacitance as a function of ambient free air temperature, typical curve.

II. IMPEDANCE



Typical Values

1 = 180 NF @ 1000VDC

2 = 10 NF @ 1600VDC

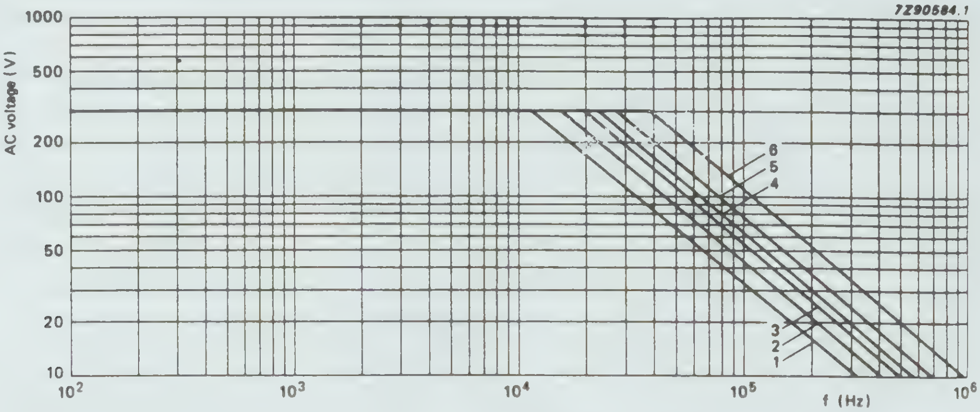
3 = @ 1 NF 2000VDC

SERIES 719F1 (TYPE KP/ MMKP)

Part 2

III. VOLTAGE

@ 300 VAC
(630 VDC)

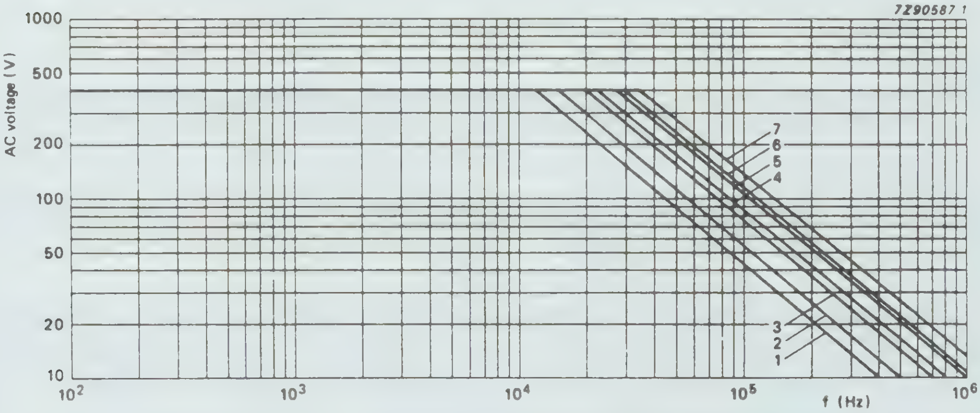


Curve 1: 0,27 μF
Curve 2: 0,12 μF
Curve 3: 0,056 μF
Curve 4: 0,027 μF
Curve 5: 0,022 μF
Curve 6: 0,0068 μF

AC voltage (V)

Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leq 85°C$ for U_R (DC) = 630 V.

@ 400 VAC
(1000 VDC)



Curve 1: 0,18 μF
Curve 2: 0,082 μF
Curve 3: 0,047 μF
Curve 4: 0,027 μF
Curve 5: 0,015 μF
Curve 6: 0,0082 μF
Curve 7: 0,0047 μF

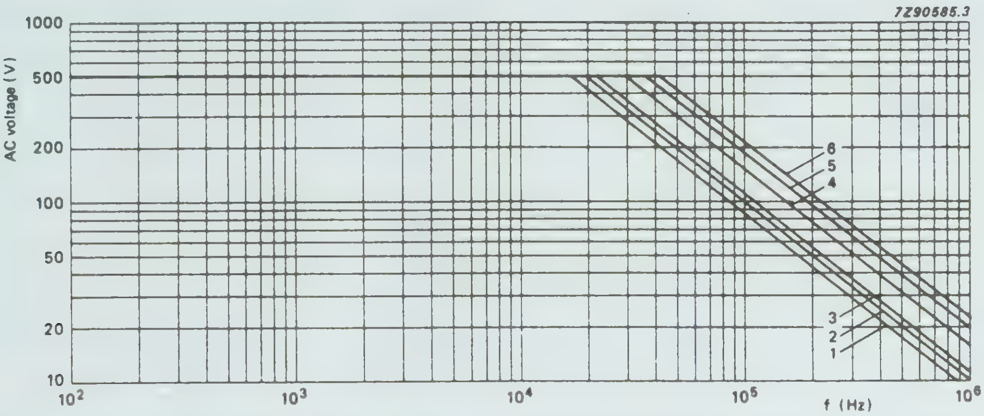
AC voltage (V)

Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leq 85°C$ for U_R (DC) = 1000 V.

4 Film Capacitors

Part 2

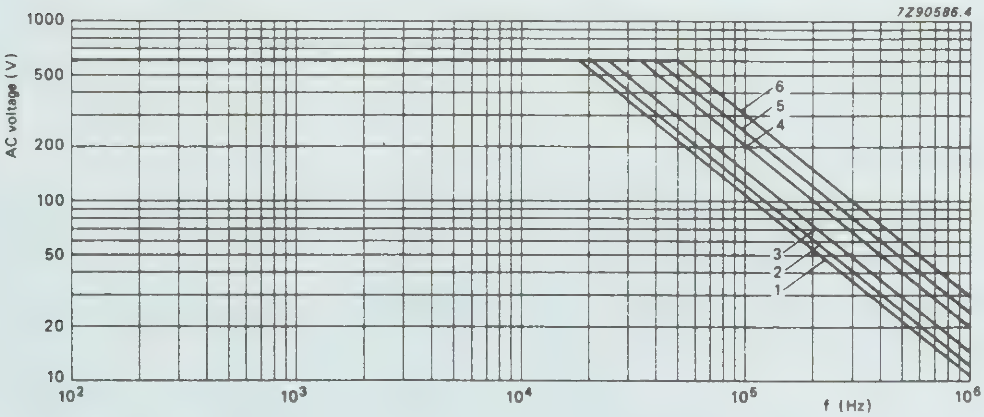
@ 500 VAC
(1600 VDC)



Curve 1: 0,056 μF
Curve 2: 0,027 μF
Curve 3: 0,015 μF
Curve 4: 0,0068 μF
Curve 5: 0,0039 μF
Curve 6: 0,0018 μF

Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leq 85°C$ for U_R (DC) = 1600 V.

@ 600 VAC
(2000 VDC)



Curve 1: 0,033 μF
Curve 2: 0,015 μF
Curve 3: 0,01 μF
Curve 4: 0,0039 μF
Curve 5: 0,0027 μF
Curve 6: 0,001 μF

Rated AC voltage (RMS value) as a function of frequency at $T_{amb} \leq 85°C$ for U_R (DC) = 2000 V.

AC voltage (V)

Rated Voltage Pulse Slope (All Values):
Not Applicable, Limited By Network Conditions

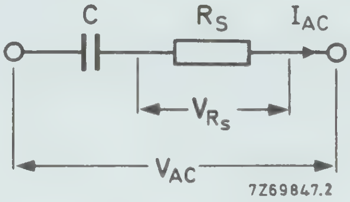
SERIES 719F1 (TYPE KP/MMKP)

Part 2

IV Power dissipation (maximum)

The power dissipated by a capacitor is a function of the voltage across the series resistance (R_s) or of the current through the series resistance and is expressed by:

$$P = \frac{V_{R_S}{}^2}{R_s} = I^2{}_{AC} R_s$$



Power dissipation as a function of the voltage across a series resistance.

$$V_{R_S}{}^2 = \frac{R_s{}^2}{R_s{}^2 + 1/\omega^2 C^2} V_{AC}$$

Given that than $\delta = R_s \omega C < 0.1$, the formula (2a) can be simplified to

$$V_{R_s}{}^2 = R_s{}^2 \omega^2 C^2 V^2{}_{AC}$$

and with $R_s = \tan \delta / \omega C$, the formula becomes

$$P = \omega C \tan \delta \ V^2{}_{AC}$$

or

$$P = \frac{\tan \delta}{\omega C} I^2{}_{AC}$$

The value of tan δ can be calculated by reference to Fig. 2; C is in Farads, $\omega = 2\pi f$, V_{AC} or I_{AC} are assumed to be known.

The maximum permissible value of power dissipation (P max.), which is dependent on the dimensions of the capacitor and on the ambient free air temperature can be found by reference to Fig. 1.

In application where sine-waves occur, the RMS voltage and the RMS current of the sine-wave are to be used to obtain the values for $V^2{}_{AC}$ and $I^2{}_{AC}$ respectively.

In applications where periodic signals occur, the signal has to be expressed in Fourier terms:

$$V_{AC} = V_o + \sum_{k=1}^{\infty} V_k \sin (k\omega t + \varphi k)$$

$$I_{AC} = \sum_{k=1}^{\infty} I_k \sin (k\omega t + \varphi k)$$

which for dissipated power becomes

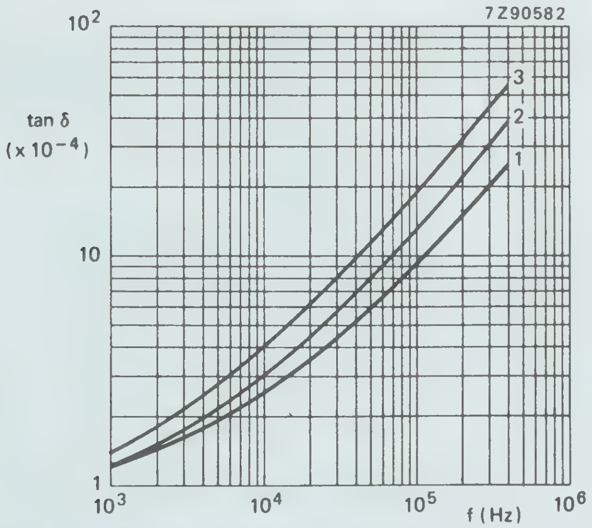
using expression (5): $P = \sum_{k=1}^{\infty} 1 \omega C \tan \delta (\omega k) \frac{V_k^2}{2}$

using expression (6): $P = \sum_{k=1}^{\infty} \frac{\tan \delta \ (\omega k) \ 1_k^2}{k\omega C \qquad 2}$

Part 2

Table 1 Power dissipation in capacitors of different dimensions (see below).

curve	dimensions (mm)		
	$T_{max.}$	$H_{max.}$	$L_{max.}$
1	5	11	17,5
2	6	12	17,5
3	7	13	17,5
4	8,5	14,5	17,5
5	6	15,5	26
6	7	16,5	26
7	8,5	18	26
8	10	19,5	26
9	9	19	31
10	11	21	31
11	13	23	31
12	15	25	31
13	18	28	31



Curve 1 = 15 mm pitch; all series
22,5 mm pitch;
1000 V series
1600 V series
2000 V series

Curve 2 = 22,5 mm pitch;
630 V series
27,5 mm pitch;
1000 V series
1600 V series
2000 V series

Curve 3 = 27,5 mm pitch;
630 V series

Fig. 2 Tangent of loss angle (maximum value) as a function of frequency.

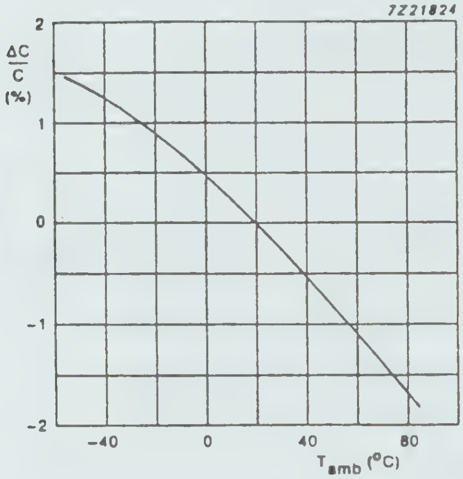
SERIES 719F2 (TYPE MKP OR MKP/MKP)

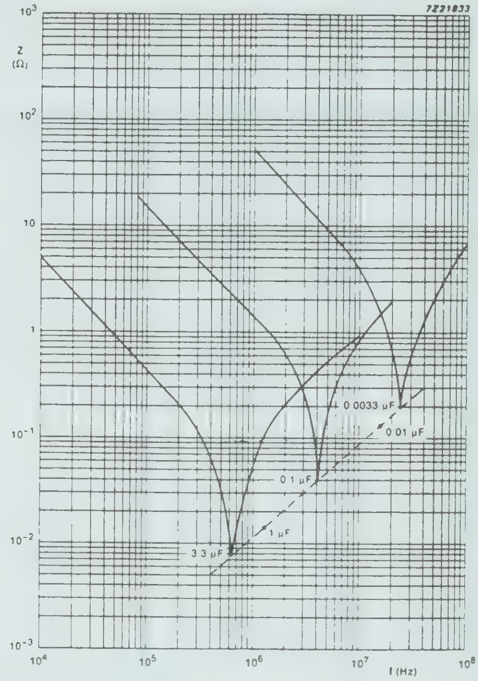
Part 3

I. CAPACITANCE

Temperature characteristics:
-55 to $+20°C$: $0 \leq \frac{\Delta C}{C} \leq 3.75\%$

20 to 85°C: $-3.25\% \leq \frac{\Delta C}{C} < 0\%$



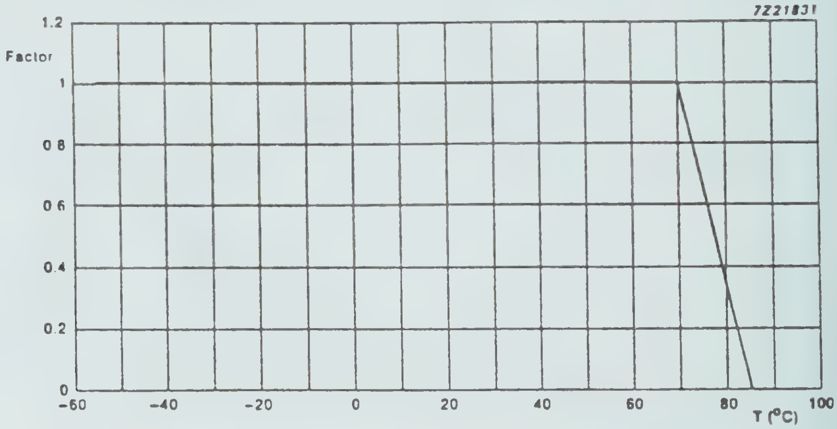


Impedance as a function of frequency; typical curve.

III. VOLTAGE

A. DC Voltage Rating @ 85°C (See Size Chart)
B. AC Voltage Rating @ 70°C (See Size Chart) or per information below.

Maximum RMS voltage as a function of temperature: The maximum RMS voltage must be multiplied by a factor depending on the ambient temperature

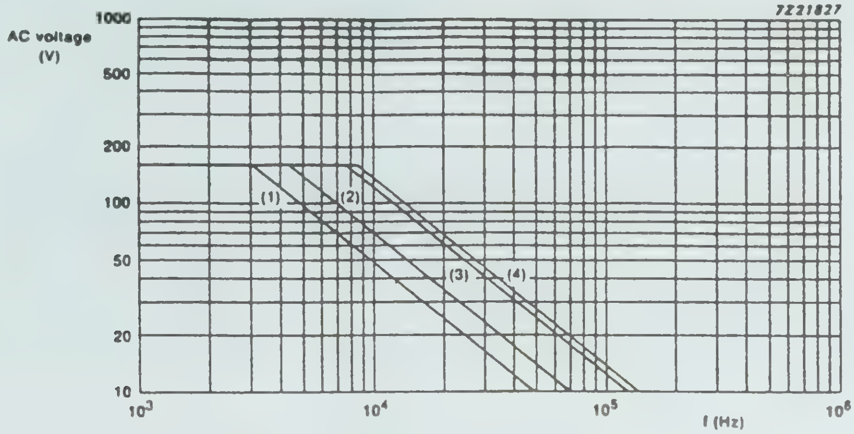


Multiplying factor as a function of temperature.

Notes
1. The sum of the DC voltage and the peak value of the superimposed AC voltage must be $\leq U_R$ (DC).
2. For waveforms other than sinusoidal the maximum permissible dissipation must not be exceeded.

Part 3

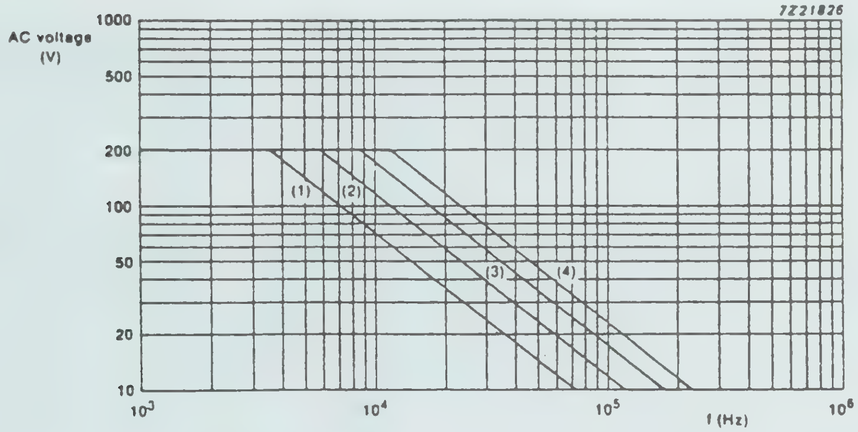
@ 160 VAC
(250 VDC)



Curve 1 = 3.3 μF;
Curve 2 = 1μF;
Curve 3 = 0.47 μF;
Curve 4 = 0.33 μF.

AC voltage (RMS value) as a function of frequency at T_{amb} $\leq 70°C$ for U_R (DC) = 250 V.

@ 200 VAC
(400 VDC)



Curve 1 = 1.8 μF;
Curve 2 = 1μF;
Curve 3 = 0.47 μF;
Curve 4 = 0.18 μF.

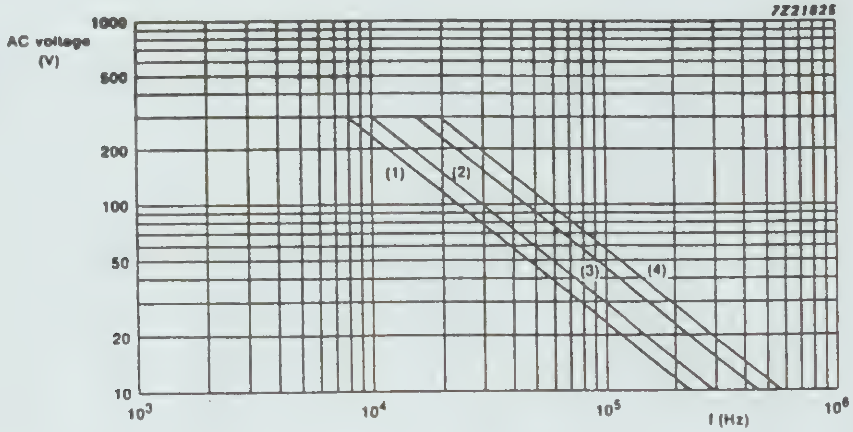
AC voltage (RMS value) as a function of frequency at T_{amb} $\leq 70°C$ for U_R (DC) = 400 V.

4 Film Capacitors

SERIES 719F2 (TYPE MKP OR MKP/MKP)

Part 3

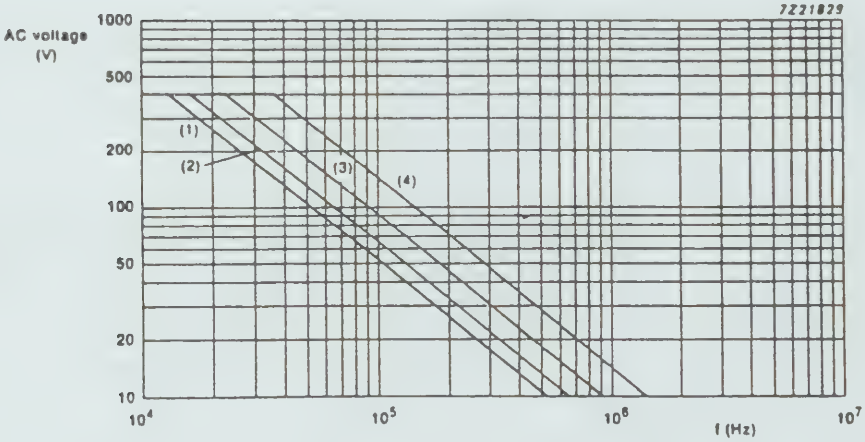
@ 300 VAC
(630 VDC)



Curve 1 = 0.68 μF;
Curve 2 = 0.33 μF;
Curve 3 = 0.10 μF;
Curve 4 = 0.056 μF.

AC voltage (RMS value) as a function of frequency at T_{amb} $\leq$70°C for U_R (DC) = 630 V.

@ 400 VAC
(1000 VDC)



Curve 1 = 0.22 μF;
Curve 2 = 0.1μF;
Curve 3 = 0.047 μF;
Curve 4 = 0.012 μF.

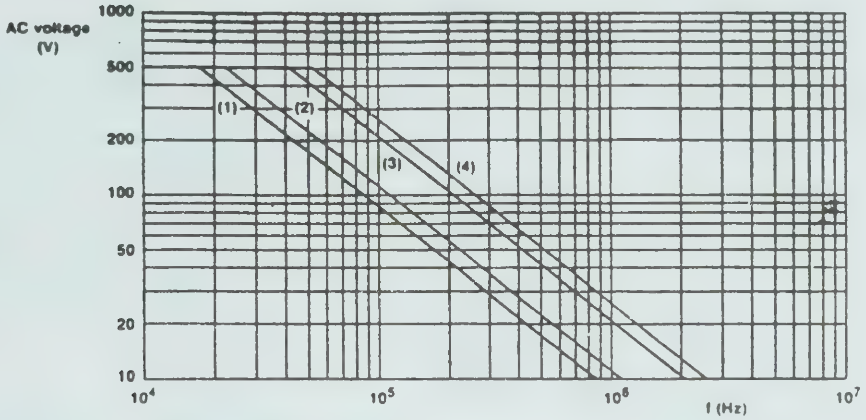
AC voltage (RMS value) as a function of frequency at T_{amb} $\leq$70°C for U_R (DC) = 1000 V.

4

Film Capacitors

Part 3

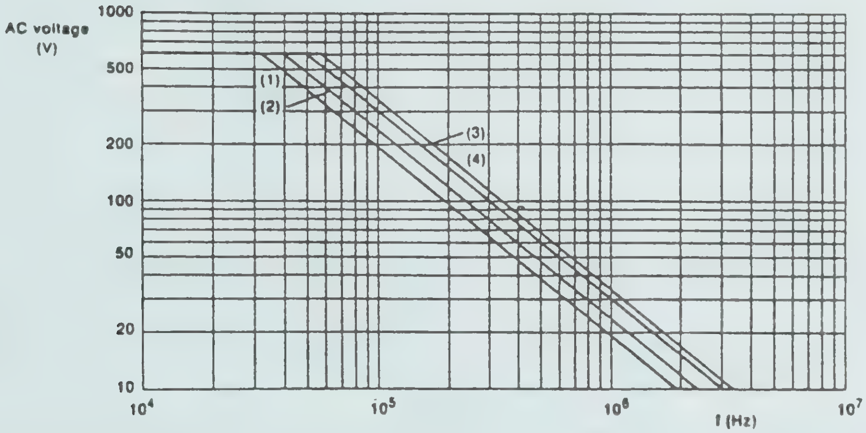
@ 500 VAC
(1600 VDC)



Curve 1 = 0.1 μF;
Curve 2 = 0.47 μF;
Curve 3 = 0.01 μF;
Curve 4 = 0.0056 μF.

AC voltage (RMS value) as a function of frequency at T_{amb} ≤70°C for U_R (DC) = 1600 V.

@ 600 VAC
(2000 VDC)



Curve 1 = 0.015 μF;
Curve 2 = 0.010 μF;
Curve 3 = 0.0047 μF;
Curve 4 = 0.0033 μF.

AC voltage (RMS value) as a function of frequency at T_{amb} ≤70°C for U_R (DC) = 2000 V.

SERIES 719F2 (TYPE MKP OR MKP/ MKP)

Part 3

Table 1 Rated voltage pulse slope

rated voltage	rated voltage pulse slope (V/μs)	
V	1 = 26 mm	L = 31 mm
250	90	60
400	100	70
630	370	230
1000	1200	600
1600	1600	900
2000	2000	1200

The rated voltage pulse slopes in the table are valid for pulse voltages equal to the rated voltage. For lower pulse voltages the given values may be multiplied by U_R/applied voltage.

Note

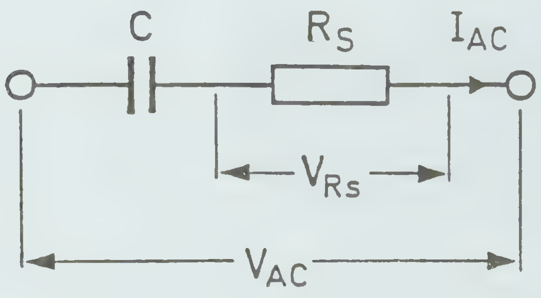
If the pulse slope requirement is satisfied, a check must be made to ascertain that the maximum dissipation is not exceeded.

IV. MAXIMUM DISSIPATION

The power dissipated by a capacitor is a function of the voltage across the series resistance (R_S) or of the current through the series resistance and is expressed by

$$P = \frac{V_{Rs}{}^2}{R_s}$$

$$= I^2_{AC} \ R_s$$



Power dissipation as a function of the voltage across a series resistance.

$$V_{R_S}{}^2 = \frac{R_s{}^2}{R_s{}^2 + 1/\omega^2 C^2} V_{AC}$$

Given that than $\delta = R_s\omega C < 0.1$, the formula (2a) can be simplified to

$$V_{R_S}{}^2 = R_s{}^2\omega^2C^2V^2{}_{AC}$$

and with $R_s = \tan\delta/\omega C$, the formula becomes

$$P = \omega C \tan\delta \ V^2{}_{AC}$$

or

$$P = \frac{\tan\delta}{\omega C} I^2{}_{AC}$$

The value of tan ω can be calculated by referenc[e] to Fig. 1; C is in Farads, $\omega = 2\pi f$, V_{AC} or I_{AC} ar[e] assumed to be known.

The maximum permissible value of power dissi[-]pation (P max.), which is dependent on the dimen[-]sions of the capacitor and on the ambient free ai[r] temperature can be found by reference to Fig. 2.

In applications where sine-waves occur, the RM[S] voltage and the RMS current of the sine-wav[e] are to be used to obtain the values for $V^2{}_{AC}$ an[d] $I^2{}_{AC}$ respectively.

In applications where periodic signals occur, th[e] signal has to be expressed in Fourier terms:

$$V_{AC} = V_o + \sum_{k=1}^{\infty} V_k \sin(k\omega t + \rho k)$$

or $$I_{AC} = \sum_{k=1}^{\infty} I_k \sin(k\omega t + \rho k)$$

which for dissipated power becomes–

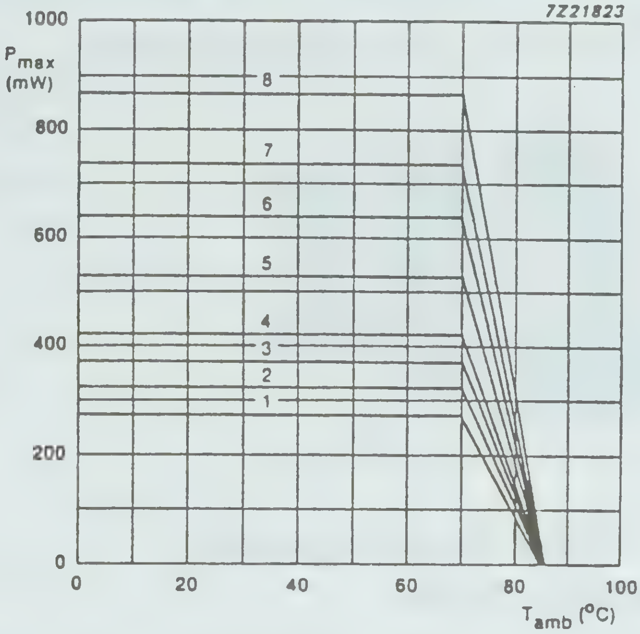
using expression (5): $$P = \sum_{k=1}^{\infty} k\, C \tan\delta(\omega k) V^2{}_{k2}$$

using expression (6): $$P = \sum_{k=1}^{\infty} \frac{\tan\delta(\omega k) I^2{}_{k2}}{k\omega C}$$

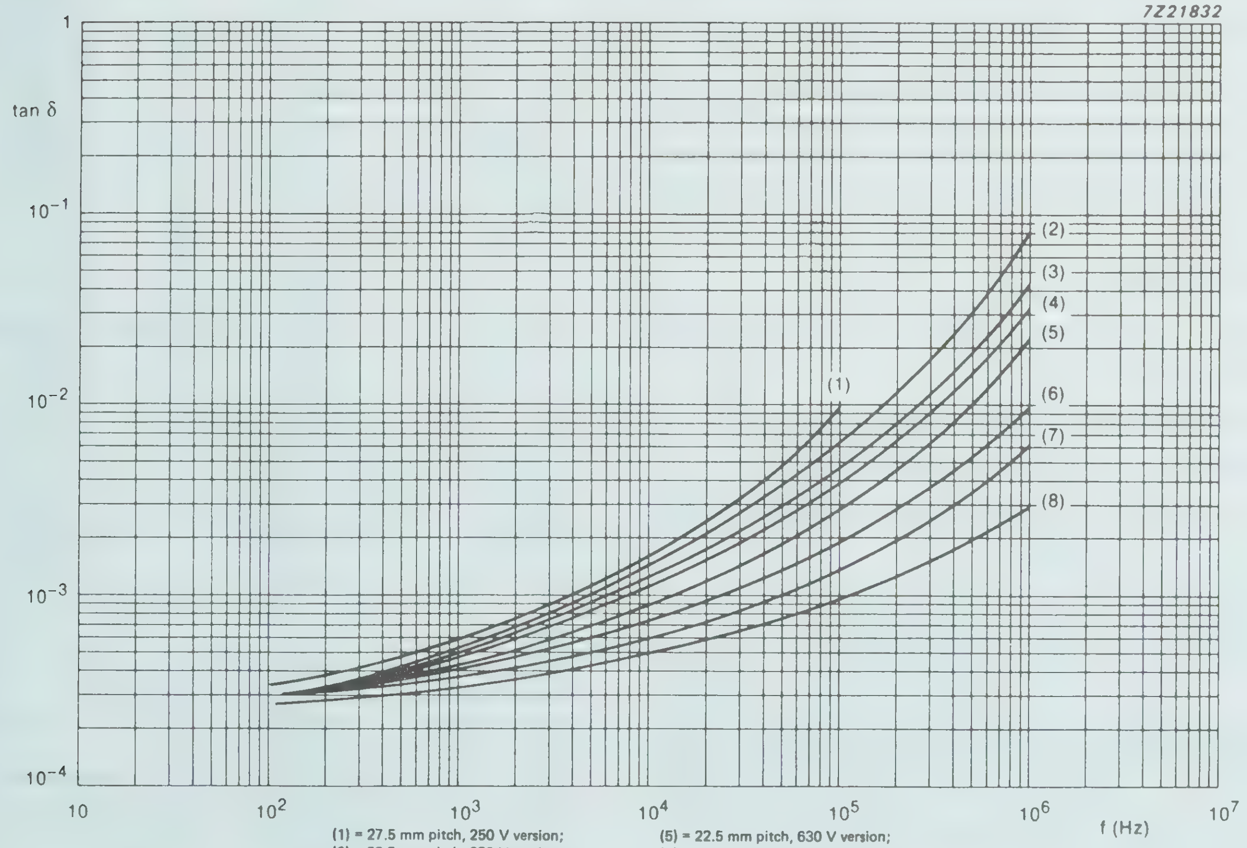
Part 3

Table 2 Power dissipation for different dimensions

Curve (see Fig. 16)	dimensions (mm)		
	T_{max}	h_{max}	L_{max}
1	6	15.5	26
2	7	16.5	26
3	8.5	18.0	26
4	10	19.5	26
5	11	21.0	31
6	13	23.0	31
7	15	25.0	31
8	18	28.0	31



Maximum permissible power dissipation as a function of ambient free air temperature, at various capacitor dimensions.



(1) = 27.5 mm pitch, 250 V version;
(2) = 22.5 mm pitch, 250 V version;
(3) = 27.5 mm pitch, 400 V version;
(4) = 22.5 mm pitch, 400 V version;
27.5 mm pitch, 630 V version;
(5) = 22.5 mm pitch, 630 V version;
(6) = 27.5 mm pitch, 1000 V version;
(7) = 22.5 mm pitch, 1000 V version;
27.5 mm pitch, 1500 V version;
(8) = 22.5 mm pitch, 1500 V and 2000 V versions
27.5 mm pitch, 2000 V version.

Fig. 2 Tan δ-value as a function of frequency; maximum values.

4

Film Capacitors

SERIES 711H3

Dry Metalized Polypropylene Capacitors For A.C. Applications

4

Film Capacitors

'A' Style Non-Protected

DESCRIPTION

711H metalized polypropylene capacitors consist of a non-inductive wound cell housed in a round phenolic case. These capacitors are supplied to a maximum voltage of 370 VAC @ 50/60 Hz. Additional information with regard to electrical, environmental and mechanical specification is summarized on the following pages. *These capacitors are not protected—see Product Safety Statement.*

FEATURES

- Non-Inductive Windings
- Self-Healing Dielectric
- Dry Construction—Non PCB
- Rugged Mechanical Construction
- Phenolic Case Requires No Insulation
- Low Energy Consumption
- Brackets and End Caps Available
- Available Capacitance Tolerance—±10% (±3% & ±6%, available on request)

'A' STYLE CAPACITANCE DECADE VS CASE SIZE
(For special capacitance values please contact Mepco/Centralab sales office or manufacturing facility. Certain restrictions may apply to non-standard values.)

Capacitance MPD	@ 240VAC Standard Case Size	@ 370VAC Standard Case Size
3	AA (1)	AA (1)
4	AA (1)	AA (1)
5	AA (1)	AB (2)
6	AA (1)	AB (2)
7	AA (1)	AB (2)
7.5	AA (1)	AB (2)
9	AB (2)	AC (3)
10	AB (2)	AC (3)
11	AB (2)	AC (3)
12.5	AC (3)	AD (4)
15	AD (4)	AD (4)
17.5	AD (4)	AE (5)
20	AD (4)	AE (5)
22.5	AD (4)	AG (7)
25	AD (4)	AG (7)
27.5	AD (4)	AG (7)
30	AE (5)	AH (8)
35	AE (5)	AH (8)
40	AE (5)	AH (8)
45	AG (7)	AH (8)
50	AG (7)	AH (8)
55	AH (8)	Not Available
60	AH (8)	
65	AH (8)	
70	AH (8)	
75	AH (8)	

NOTES:
1. Capacitance tolerance: Standard ±10%(K). ±6%(H) & ±3% (L) at slightly higher costs.
2. Accessories: For mounting brackets & end caps see accessory section.
3. These capacitors are designed for operation in symmetrical sinewave circuits operating at rated 60HZ or lower. For special applications, please contact your nearest sales office, representative, or the factory.

SERIES 711H3

Dry Metalized Polypropylene Capacitors for A.C. Application

HOW TO SPECIFY

Series 711H capacitors may be specified using the following designation:
(See Capacitance Section below for more details)

711H	3	AD	106P	K	371	AA
Series	Terminal Type	Case Size & Type	Capacitance	Capacitance Tolerance	Rated Voltage	Internal Assignment

PHENOLIC

	Dia.		Ht.
(1)AA=	1.437"	x	2.750"
(2)AB=	1.437"	x	3.375"
(3)AC=	1.437"	x	4.375"
(4)AD=	1.812"	x	3.375"
(5)AE=	1.812"	x	4.375"
(6)AF=	2.062"	x	3.375"
(7)AG=	2.062"	x	4.375"
(8)AH=	2.562"	x	4.375"

TERMINAL TYPE

3=(2) 2BQC
4=Open
5=Open
6=(2) 1BQC
7=(2) 2BQC w/Solder Lug
8=(2) Solder Lugs
9=Lead Wire

FIRST ALPHA OF CODE (6th Field Part Number)

A=Phenolic
B=Plastic
C=Open
D=Open
E=Wrap & Pot
F-Z=Open

4

Film Capacitors

CAPACITANCE

For whole capacitance values in micro farads, Columns 8 & 9 contain significant digits, Column 10 contains the number of zeros, Column 11 contains a 'P'. For fractional capacitance values in Microfarads, Columns 8 & 9 contain significant digits, Column 10 contains the fractional value and Column 11 contains the number of zeros. The 'P' is dropped.

Multipliers

1 = 0	6 = 000000	
2 = 00	7 = 0000000	
3 = 000	8 = 00000000	
4 = 0000	9 = 000000000	
5 = 00000	0 = None	

Example

25μf = 256P
12.5μf = 1256
8μf = 805P

CAPACITANCE TOLERANCE

L=±3%
H=±6%
K=±10% (STANDARD)
A=±Special

VOLTAGE RATING

Column #13 & 14 are significant digits. Column #15 gives number of zeros.

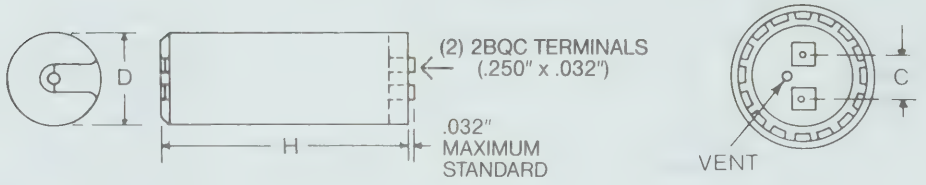
EXAMPLE: 240VAC = 241
370VAC = 371

INTERNAL ASSIGNMENT

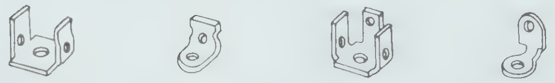
Used to denote individual customers.
'AA' is used to designate a standard part not specifically assigned to a specific customer.

SERIES 711H3
Dry Metalized Polypropylene Capacitors for A.C. Application "A" Style

CASE OUTLINE DRAWING



TERMINAL TYPES



2 Blade QC — 1 Blade QC — 2 Blade QC with solder lug — Solder lug

(Quick-connect terminals are also suitable for soldered connections)

Case Code	Case Diameter 'D'		Case Height 'H'		Terminal C-C 'C'	
	Inches (±.015)	mm (±.38)	Inches (±.032)	mm (±.81)	Inches (±.005)	mm (±.13)
AA (1)	1.437	36.5	2.750	69.9	.500	12.7
AB (2)	1.437	36.5	3.375	85.7	.500	12.7
AC (3)	1.437	36.5	4.375	111.1	.500	12.7
AD (4)	1.812	46.0	3.375	85.7	.625	15.9
AE (5)	1.812	46.0	4.375	111.1	.625	15.9
AF (6)	2.062	52.4	3.375	85.7	.812	20.6
AG (7)	2.062	52.4	4.375	111.1	.812	20.6
AH (8)	2.562	65.1	4.375	111.1	.812	20.6

"A" STYLE

TYPICAL MARKING EXAMPLE

1ST LINE — MANUFACTURERS NAME
2ND LINE — PART NUMBER
3RD LINE — RATED CAPACITANCE, TOLERANCE, CUSTOMER PART NUMBER IF REQUIRED
4TH LINE — RATED VOLTAGE, FREQUENCY, & DATE CODE
5TH LINE — CAPACITOR TYPE — NOT PROTECTED

EXAMPLE (RED LABEL WITH WHITE CHARACTERS)

Philips Components
711H3AD106PK371AA
10μF ±10% [ ]
370 VAC 60HZ 362 [DATE]
DRY FILM CAP — NOT PROTECTED

Dry Metalized Polypropylene Capacitors for A.C. Application

A.C. FILM CAPACITOR SPECIFICATIONS & TEST METHODS

I. Physical

A. See appropriate section for standard ratings, sizes & physical characteristics.

B. All 'A' style capacitor cases are made from mineral filled thermoset phenolic for durability & corrosion resistance. The case material has a U.L. temperature index of 150°C and a U.L. 94V-1 minimum flamability rating.

C. Capacitors may be mounted in any position.

II. Temperature Rating—these capacitors are rated as follows:

A. *Operating Case Temperature*—40°C to +70°C (−40°F to +158°F)

B. *Storage (Ambient)*—40°C to +90°C (−40°F to +194°F)

C. *Temperature Rating*—"Capacitors shall have rated life performance when operated within case temperature range. Operation at higher case temperatures will result in reduced life."

III. Voltage Rating

Philips Components metalized film capacitors are rated for stable operation at the rated voltage. Decreased life can be expected if the capacitors are operated at 110% of the rated voltage at 60HZ provided the maximum case temperature is not exceeded. Special voltage ratings are available. Please contact the factory.

IV. Capacitance & Tolerance

All capacitors supplied shall be within the specified limits of rated capacitance when measured at a temperature of +25°C. Standard capacitance tolerance is ±10%. Tolerances of ±6%, ±3% capacitance are available upon request.

All capacitance measurements shall be made on an A.C. bridge at a frequency of 60HZ or referred to measurements made at that frequency.

A. Capacitance change with temperature—when capacitance is measured at the maximum & minimum rated case temperatures, the capacitance will vary no more than −5% to +2% of the +25°C capacitance value.

V. Rated Life

"When operated @ rated voltage & rated case temperature (70°C max), capacitor survival shall be not less than 94% after 60,000 hours operation. After 5000 hours operation, survival shall be not less than 99% with capacitors operating at rated conditions."

"The useful life of the capacitor will be shortened by exceeding the rated voltage and/or temperature limits. Acceleration effects of temperature & voltage are now under study."

VI. Volt-Ampere Loading

"Capacitors shall be capable of operating at a volt ampere loading resulting from the combined effects of capacitance tolerance, frequency variations, voltage & harmonics, not exceeding 130% of the volt-ampere loading calculated at rated capacitance & at rated 60HZ (sinusoidal) voltage, provided rated case temperature is not exceeded." Please contact the factory prior to using these capacitors at a VA higher than rated.

VII. Dissipation Factor

The dissipation factor of each capacitor shall not exceed 0.1% when measured at or referred to 60HZ rated voltage applied at any temperature between 23°C & the capacitors maximum rated case temperature.

VIII. Dielectric Strength

Terminal-to-Terminal—The capacitors are capable of withstanding the applications of 1.75 x rated A.C. voltage for one (1) second. Capacitors should be discharged through a 10,000 Ohm resistor to limit the current.

Terminal-to-Case—The capacitors are capable of withstanding an application of 2 x rated A.C. voltage plus 1000 volts for one (1) second.

NOTE: An alternate test method may be used by applying a D.C. voltage equal to the peak voltage of the specified A.C. test voltage. (The capacitors must be charged & discharged through a 10,000Ω resistor.)

SERIES 711H3

Dry Metalized Polypropylene Capacitors for A.C. Application "A" Style

IX. Life Tests

A. High temperature life test—tested @ 125% x rated A.C. @ 80°C for 500, 1500, or 2000 hours (circulating air).

B. Room temperature life test—test @ 135% x rated A.C. @ room temperature for 120 hours (circulating air).

NOTE: These life tests are designed to indicate the relative quality of the capacitor lot being tested. Actual life in application can only be determined after extensive long-term test data accumulation.

C. The typical results expected after a life test are:
   1. No short circuits between terminals or terminals & case
   2. No intermittent or continuous open circuits between terminals
   3. A typical D.F. ≦ .10% @ 60Hz
   4. Capacitance loss—
      'A' Style—
      (240VAC Rated) 2000 hour test %$\triangle$C=≤3%
      (370VAC Rated) 500 hour test %$\triangle$C=≤10%

X. Environmental Tests

Philips Components metalized film capacitors meet or exceed the applicable environmental tests recommended by E.I.A.

BRACKET DIMENSIONS

DRAWING NO.	A	B	C	D	E
614A765ABP1	5.015	4.656	2.0	–	2.078
614A765ABP2	4.015	3.650	1.703	.906	1.578
614A765ABP3	3.374	3.015	1.062	.586	1.258

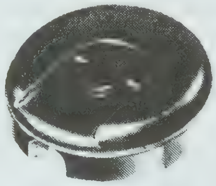
CASE SIZE	END CAPS		BRACKETS
	LEAD HOLE DWG. #614a766****		DWG. NO. 614a765****
	BOTTOM	TOP	
AA (1)	AAP001	ABP001	ABP003
AB (2)	AAP001	ABP001	ABP002
AC (3)	AAP001	ABP001	ABP001
AD (4)	AAP002	ABP002	ABP002
AE (5)	AAP002	ABP002	ABP001
AF (6)	AAP003	ABP003	ABP002
AG (7)	AAP003	ABP003	ABP001
AH (8)	AAP004	ABP004	ABP001

ACCESSORY ITEMS

Order as separate items
'A' Style Only

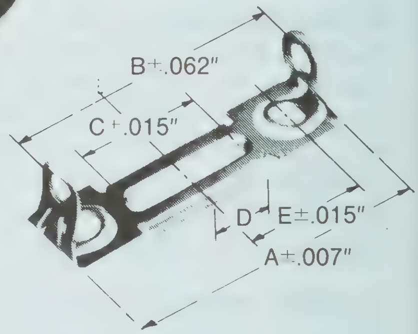
END CAPS

Bottom Lead Hold



Top Lead Hole

BRACKET DRAWING



ORDERING INFORMATION

1. (1) one cap & (1) bracket required per capacitor.
2. When ordering caps (614A766****) or brackets (614A765****) insert the appropriate alpha/numeric code from the chart above.

DISCHARGE RESISTOR

Some applications require that the capacitor discharge automatically once the voltage source is disconnected. This minimizes the shock hazard. Normally a 15K Ohm 20% 2 watt resistor is used. Other resistance values are available upon request. Consult the factory for this option.

SERIES 711H3

Dry Metalized Polypropylene Capacitors for A.C. Application

CAPACITOR COMPARISON SHEET

Characteristic	Dry Metalized Film	Wet Metalized Film	Free Foil/Oil Filled Paper or Paper/Film Cap
Failure Mode	Self-healing open circuit failure mode typical.	Same as dry	Short Circuit
Capacitance Stability	Excellent–self-healing implies capacitance loss during life thru electrode evaporation, oxidation or erosion.	Same as dry	Good
High Voltage A.C. Operation	Working voltages up to 370VAC in a single unit can be used at this stage of development, up to 660VAC under certain conditions.	Same except 440VAC available	High Voltage A.C. Operation Dependent on Impregnant Used And Thickness of Paper
Current Limitation	Exceptionally high currents are not recommended.	Same as dry	None
High Frequency Operation	Lower frequency operation due to the high inductance and resistive effects of metalized electrode & end connection.	Same as dry	Up To 10MHz With Non-Inductive Construction
Capacitance Values	1–100 MFD	Same as dry	1–100 MFD
Loss (Dissipation Factor)	Typically .01 to .1% D.F. @ 60HZ @ Rated VAC	Same as dry	Typically .3 to .6% D.F. @60HZ @ Rated Voltage
Size & Weight	Smallest & Lightest/M.F.D.	Between oil filled, free foil & dry metalized	Largest & Heaviest/M.F.D.
Life	Typically 60,000 Hours Plus	Same as dry	Typically 60,000 Hours
U.L. Requirements & Impregnant	No impregnant, no oil to leak. Some applications require UL Recognized capacitors.	Same as oil filled free foil	Oil filled must be protected per U.L. requirement. Free oil combustible & can leak & be a serious hazard.

CAUTION

Philips Components 711H series capacitors are housed in flame-retardant thermoset phenolic cases and do not contain internal protection.

Before these products are energized, to avoid possible damage from overheating or rupture, they must be separately housed in a suitable enclosure.

Also, each part shall be marked with the words "not protected."

Some capacitors' failure modes could cause the capacitor's case to rupture due to internally generated gases. Please read the following information before energizing the capacitors. If you have any questions, please contact your local Philips Components Field Sales Representative or the Philips Components Film Capacitor Facility, Columbia, South Carolina.

NOTICE

Misapplication, such as exceeding design limits may result in destruction or explosion of capacitors.

SERIES 719J1 (RADIAL) (TYPE MKT-P)

Metalized Polyester and Paper Capacitors For Interference Suppression (Philips 2222-330 Series)

DESCRIPTION

Series 719J1 (Radial) low-inductance wound cell of impregnated metalized polyester and paper capacitors incapsulated in precision made flame retardant polypropylene cases. The leads are solder coated copper wire.

PERFORMANCE CLASS X2 QUALIFIED ACCORDING TO VDE 565-1, SEMKO, IMQ & UL1283.

APPLICATION

For Radio Interference Suppression In:

- Small Household Appliances e.g. Coffee Grinders, Mixers
- Audio and TV Circuits
- General Industrial Applications; e.g. Test & Measuring Equipment.

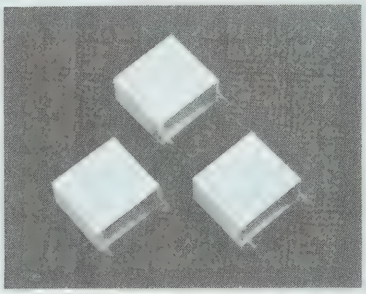
FEATURES

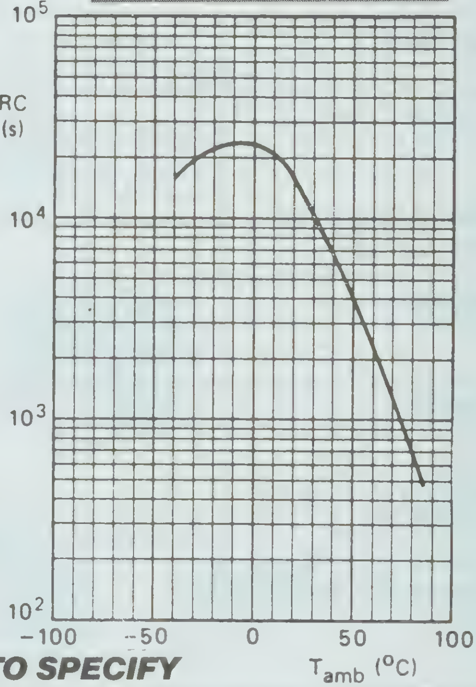
Electrical

- Insulation resistance
  The insulation resistance is measured after a voltage of 100 ±15 V has been applied for 1 min. ±5 s, at T_{amb}=20°C.
  - R between terminations, for $C_R \leq 0{,}33\mu F$ >15000MΩ
  - RC between terminations, for $C_R > 0{,}33\mu F$ > 5000 s
  - R between interconnected terminations and case (foil method) >30000MΩ
- Rated Capacitance Range .01 to 1.0 μF
- Tolerance on Rated Capacitance ±20%, ±10%
- Standard Voltage 250 VAC @ +85°C
- Climatic Category 40/85/21
- Related Specification IEC 384-14
- Max. Pulse Load 100V/μS
- Dissipation Factor
  @ 1KHz ≤ 75 x 10^{-4}
  @ 10KHz ≤ 130 x 10^{-4}
- Test Voltage
  Between terminals 1075 VDC
  Between interconnected terminals & case 2000 VAC (foil method)

Mechanical

- Flame Retardant
- Precisely Dimensioned Cases
- Self-Healing
- Solvent Resistant
- Suitable For PC Board Insertion
- Available Bulk only





RC-product as a function of ambient free air temperature; typical

HOW TO SPECIFY

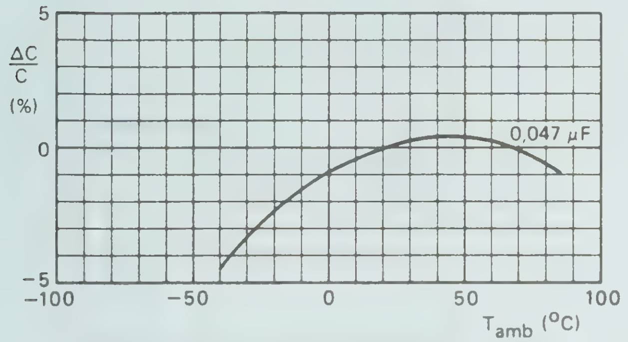
Series 719J1 Capacitors may be specified using the following designation:
(See General Part Number Description for more details)

719J1 GG 104P M 251 S B

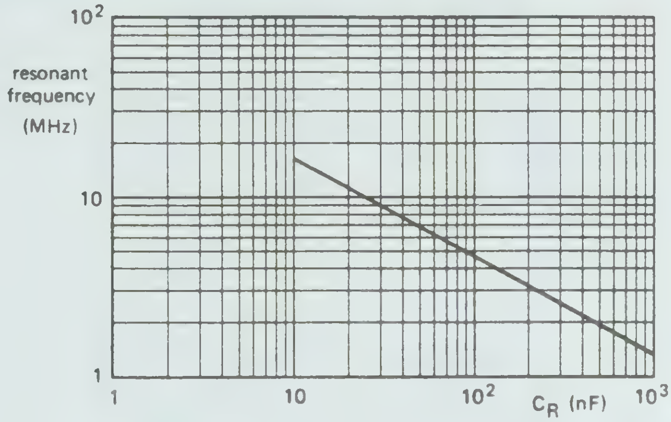
- **719J1** — **Series**
- **GG** — **Case Size**
- **104P** — **Capacitance in (pF)**: In this example the first two digits represent significant figures and last digit indicates the number of zeros to follow. P = Place Holder
- **M** — **Tolerance**: K=±10%, M=±20%
- **251** — **Voltage at 85°C**: 251=250C
- **S** — **Specification**: S=Short Leads, L=Long Leads
- **B** — **Lead Configuration**

Straight Lead Code	Lead Spacing
B	0.591″ (15 mm)
D	0.886″ (22.5 mm)
E	1.080″ (27.5 mm)

 Philips Components • 6071 St. Andrews Road • Columbia, SC 29212-3198 • (803) 772-2500 • FAX: (803) 772-2445



Capacitance as a function of ambient free air temperature; typical curve.



Resonant frequency as a function of rated capacitance.

CASE SIZE TABLE SERIES 719J1 (RADIAL)

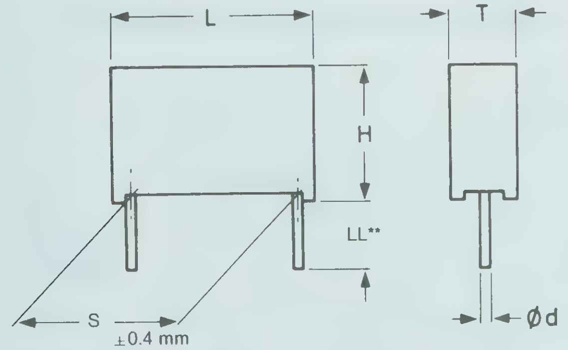
CASE SIZE CODE	SERIES 719J1 (RADIAL)									
	"L" LENGTH		"H" HEIGHT		"T" THICKNESS		"S" SPACING		"d" LEAD DIA.	
	INCHES	mm	INCHES	mm	INCHES	mm	INCHES	mm	AWG	INCHES
GD	.689	17.5	.433	11.0	.197	5.0	.591	15.0	20	.032
GE	.689	17.5	.477	12.0	.236	6.0	.591	15.0	20	.032
GF	.689	17.5	.532	13.5	.276	7.0	.591	15.0	20	.032
GG	.689	17.5	.591	15.0	.335	8.5	.591	15.0	20	.032
MH	1.020	26.0	.630	16.0	.276	7.0	.886	22.5	20	.032
MJ	1.020	26.0	.670	17.5	.335	8.5	.886	22.5	20	.032
ML	1.020	26.0	.729	18.5	.394	10.0	.886	22.5	20	.032
SN	1.22	31.0	.886	22.5	.531	13.5	1.08	27.5	20	.032
SP	1.22	31.0	.984	25.0	.591	15.0	1.08	27.5	20	.032
SR	1.22	31.0	1.10	28.0	.709	18.0	1.08	27.5	20	.032

TYPICAL MARKING EXAMPLE

SERIES 719J1

ON TOP (LINE ONE)
RATED CAP μF/TOL. ±10%=K,
±20% NOT IDENTIFIED
RATED VOLTAGE & PERFORMANCE
CLASS
PHILIPS TYPE NO. & (LINE TWO)
CODE FOR DIELECTRIC MKT-P
(LINE 3)
CLIMATIC CATEGORY, DATE CODE
APPROBATION & PHILIPS SYMBOLS

OUTLINE DRAWING SERIES 719J1



LL**
SHORT LEADS 5±1 MM (.157/.236 INCH) LENGTH
LONG LEADS LENGTH 25±2 mm (.906"/1.06")

SERIES 7191J1 (RADIAL)		
0.010	719J1GD103P*251SB	GD
0.015	GD153	GD
0.022	GD223	GD
0.033	GD333	GD
0.047	GE473	GE
0.068	GF683	GF
0.10	GG104	GG
0.15	719J1MH154P*251SD	MH
0.22	MJ224	MJ
0.33	719J1ML334P*251SE	ML
0.47	SN474	SN
0.68	SP684	SP
1.0	SR105	SR

*INSERT APPROPRIATE LETTER INTO PART NUMBER FOR TOLERANCE
K = ±10% M = ±20%

FINNISH (FI) APPROVED CAPACITORS ARE AVAILABLE. PLEASE CONTACT THE FACTORY. CASE SIZES AND CAPACITANCE VALUES MAY VARY.

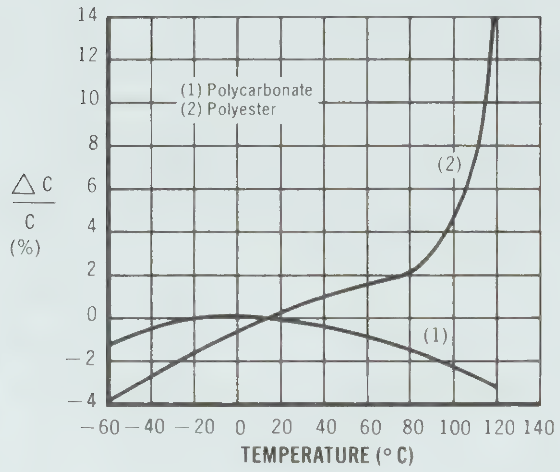
NOTICE: MISAPPLICATION SUCH AS EXCEEDING DESIGN LIMITS MAY RESULT IN DESTRUCTION OR EXPLOSION OF CAPACITORS.

SERIES 7000

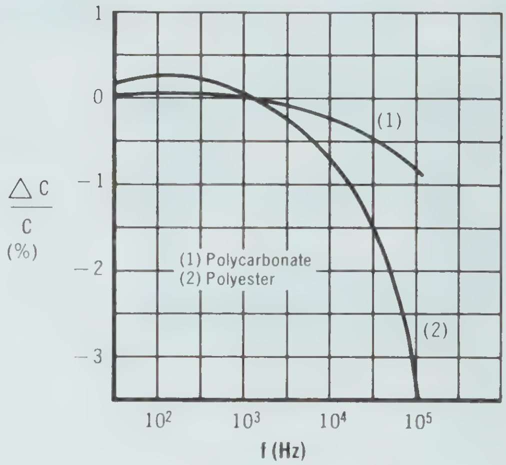
Film Capacitors Polyester & Polycarbonate

TYPICAL PERFORMANCE CURVES

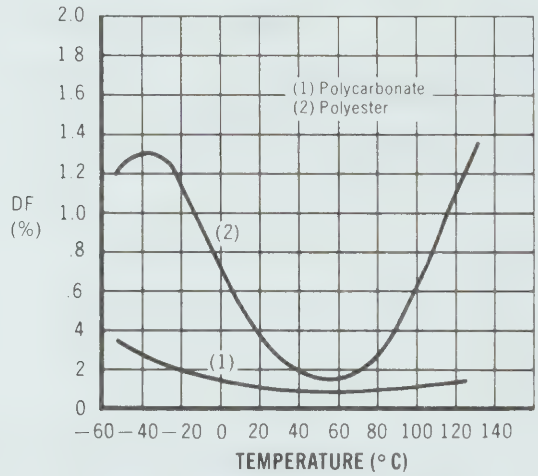
Capacitance vs. Temperature



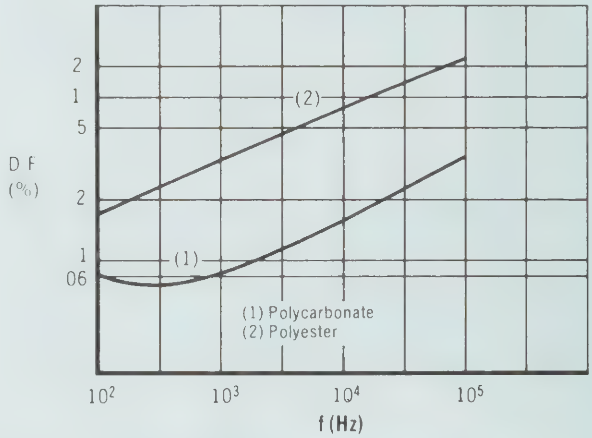
Capacitance vs. Frequency



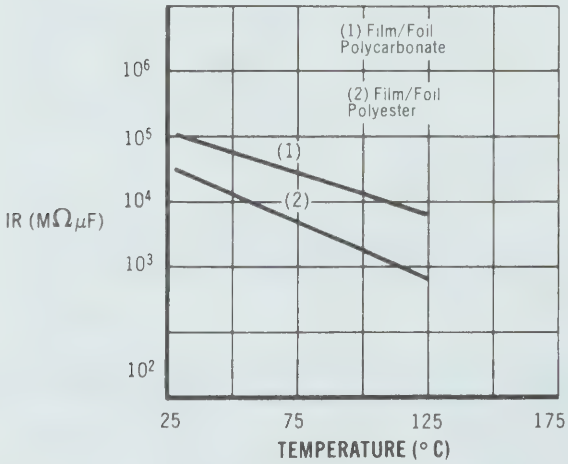
Dissipation Factor vs. Temperature



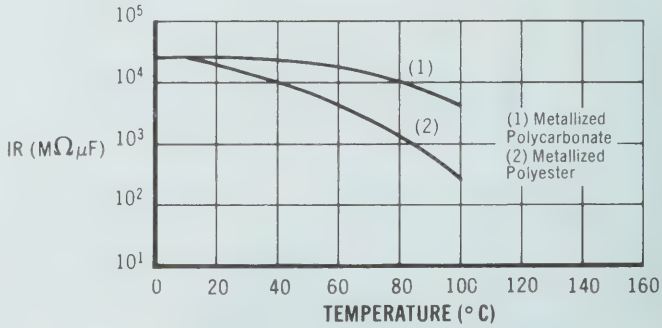
Dissipation Factor vs. Frequency



Insulation Resistance vs. Temperature

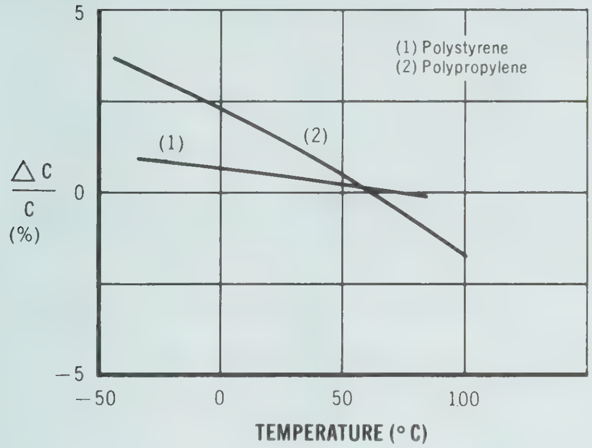


Insulation Resistance vs. Temperature

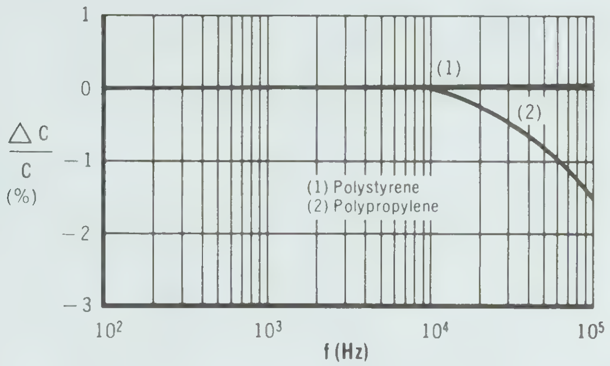


TYPICAL PERFORMANCE CURVES

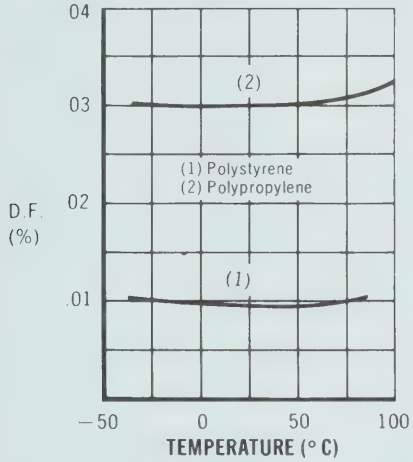
Capacitance vs. Temperature



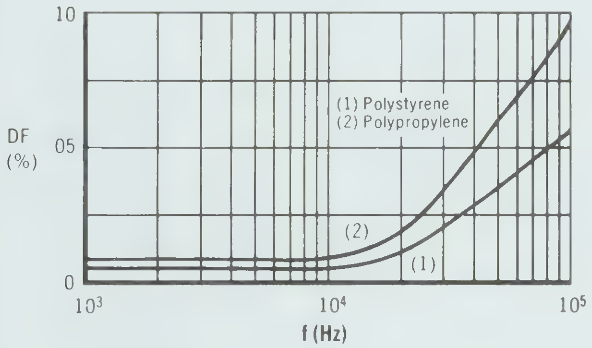
Capacitance vs. Frequency



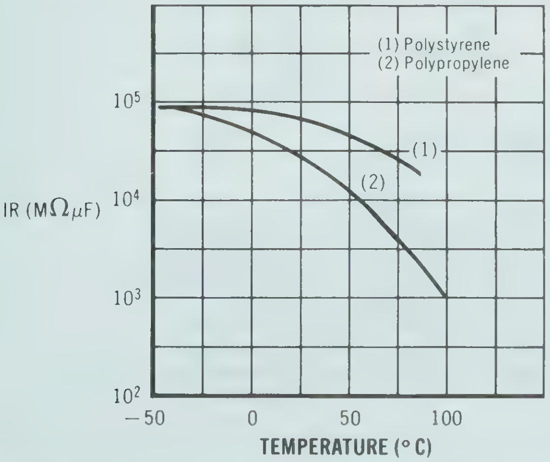
Dissipation Factor vs. Temperature



Dissipation Factor vs. Frequency



Insulation Resistance vs. Temperature



STANDARD SERIES OF VALUES IN A DECADE

STANDARD SERIES OF VALUES IN A DECADE

for resistances and capacitances

according to IEC publication 63

E192	E96	E48	E192	E96	E48	E192	E96	E48	E192	E96	E48	E192	E96	E48
100	100	100	169	169	169	287	287	287	487	487	487	825	825	825
101			172			291			493			835		
102	102		174	174		294	294		499	499		845	845	
104			176			298			505			856		
105	105	105	178	178	178	301	301	301	511	511	511	866	866	866
106			180			305			517			876		
107	107		182	182		309	309		523	523		887	887	
109			184			312			530			898		
110	110	110	187	187	187	316	316	316	536	536	536	909	909	909
111			189			320			542			920		
113	113		191	191		324	324		549	549		931	931	
114			193			328			556			942		
115	115	115	196	196	196	332	332	332	562	562	562	953	953	953
117			198			336			569			965		
118	118		200	200		340	340		576	576		976	976	
120			203			344			583			988		
121	121	121	205	205	205	348	348	348	590	590	590			
123			208			352			597					
124	124		210	210		357	357		604	604				
126			213			361			612					
127	127	127	215	215	215	365	365	365	619	619	619			
129			218			370			626					
130	130		221	221		374	374		634	634				
132			223			379			642					
133	133	133	226	226	226	383	383	383	649	649	649			
135			229			388			657					
137	137		232	232		392	392		665	665				
138			234			397			673					
140	140	140	237	237	237	402	402	402	681	681	681			
142			240			407			690					
143	143		243	243		412	412		698	698				
145			246			417			706					
147	147	147	249	249	249	422	422	422	715	715	715			
149			252			427			723					
150	150		255	255		432	432		732	732				
152			258			437			741					
154	154	154	261	261	261	442	442	442	750	750	750			
156			264			448			759					
158	158		267	267		453	453		768	768				
160			271			459			777					
162	162	162	274	274	274	464	464	464	787	787	787			
164			277			470			796					
165	165		280	280		475	475		806	806				
167			284			481			816					

E24	E12	E6	E3
10	10	10	10
11			
12	12		
13			
15	15	15	
16			
18	18		
20			
22	22	22	22
24			
27	27		
30			
33	33	33	
36			
39	39		
43			
47	47	47	47
51			
56	56		
62			
68	68	68	
75			
82	82		
91			

HOW TO INTERPRET CAPACITANCE DECADES EXAMPLES:

A decade of 100 indicates:
- 100PF...order P/N 719C1CA101PF630SF
- .001μF...order P/N 719C1CA102PF630SF
- .01μF...order P/N 719C1CB103PF630SG

A decade of 215 indicates:
- 215PF...order P/N 719C1CA2151F630SF
- .00215μF...order P/N 719C1CA2152F630SF
- .0215μF...order P/N 719C1CC2153F630SH

A decade of 324 indicates:
- 324PF...order P/N 719C1CA3241F630SF
- .00324μF...order P/N 719C1CA3242F630SF
- .0324μF...order P/N 719C1CC3243F630SH

A decade of 56 indicates:
- 56PF...order P/N 704C1AA560PF631AX
- 560PF...order P/N 704C1AA561PF251AX
- 5600PF...order P/N 704C1AC562PF630AX

4 Film Capacitors

Variable Capacitors
QUICK REFERENCE INDEX

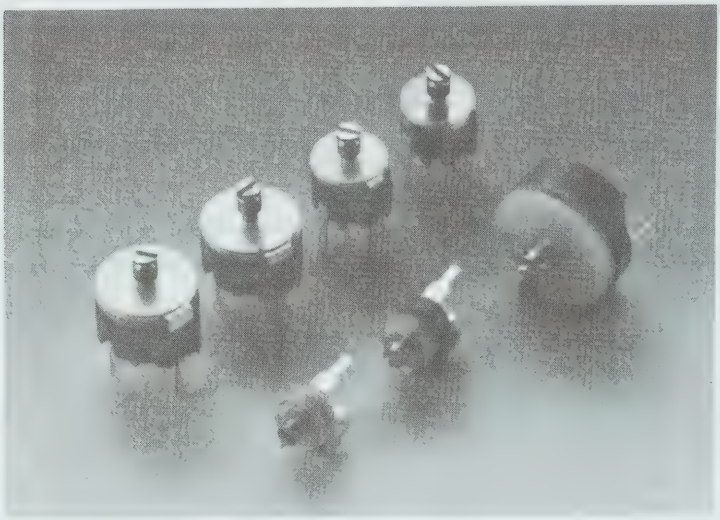
PHILIPS COMPONENTS PART NUMBER (TYPE)	CAPACITANCE RANGE	DIELECTRIC MATERIAL	OPERATING TEMPERATURE RANGE	PAGE
FILM DIELECTRIC				
2800C/K (808)	1.5pf-5pf to 7pf-100pf	Polypropylene Polycarbonate Polyethylene PTFE Teflon[R]	−40°C to +85°C or −40°C to +70°C	464
2800D/E /M (809)	0.6pf-2pf to 7pf-150pf	PTFE Teflon[R] Polycarbonate	−40°C to +125°C	472
DESIGN DATA FOR SELECTING AND APPLYING VARIABLE CAPACITOR				479

*Is a registered trademark of E.I. DuPont de Nemours

5 *Variable Capacitors*

SERIES 2800C/K (808)

Film Dielectric Trimmer Capacitors For Commercial And Industrial Applications



DESCRIPTION

5mm
The vanes of the trimmer are stacked on a sturdy plastic base, the color of which indicates the maximum capacitance. The dielectric is a film of polypropylene which supports the vanes in such a way that good stability is ensured and no microphony can occur. Flux absorption between the vanes is prevented. The trimmers are resistant to all standard cleaning solvents except trichloroethylene and trichloroethane, however, cleaning is not advised. Top adjustment should be done by means of a screwdriver and bottom adjustment by means of the key as shown in Fig. 10.

7.5mm
The vanes of the trimmers are stacked on a sturdy plastic base, the colour of which indicates the maximum capacitance. The dielectric is a film of polypropylene, polyethylene, polycarbonate or PTFE which supports the vanes in such a way that good stability is ensured and no microphony can occur. Flux absorption between the vanes is prevented.

The trimmers are resistant to all cleaning solvents except trichloroethane and trichloroethylene.

A version with vertical spindle (Fig. 2 and 3) and a version with horizontal spindle (Fig. 4) are available. Both versions have top adjustment by means of a screwdriver or trimming key, and bottom adjustment by means of a key according to Fig. 10.

10mm
The vanes of the trimmers are stacked on a sturdy plastic base, the colour of which indicates the maximum capacitance. The dielectric is a film of polypropylene, polycarbonate or PTFE which supports the vanes in such a way that good stability is ensured and no microphony can occur. Flux absorption between the vanes is prevented. The trimmers are resistant to all standard cleaning solvents except trichloroethane and trichloroethylene. Top adjustment should be done by means of a screwdriver and bottom adjustment by means of the key as shown in Fig. 10.

SERIES 2800C/K (808)

Film Dielectric Trimmer Capacitors For Commercial and Industrial Applications

HOW TO SPECIFY

SERIES 2800C Film Dielectric Trimmer Capacitors can be completely specified using the following designation:

28	10	C/K	2R515	P	J
Planar Trimmer Capacitor	**Rotor Diameter** 05= 5mm 07= 7mm 10=10mm	**Commercial Industrial Type**	**Capacitance Range** min. & max. with R denoting decimal point, i.e., 2.5pf to 15pf=2R515	**Lead Configuration** (See mounting diagram)	**Dielectric Material** J=Polyprop K=Polycarb M=Polyethylene H=PTFE Teflon®

Part Number will also include 5 additional digits on end which are for internal assignments (for reference only)

FEATURES

- Effective angle of rotation: 180°
- Operating torque:
  5mm 1 to 15 mNm (.14 to 2.1 ounce inches)
  7.5mm (6 to 22pf) 1 to 15 mNm (.14 to 2.1 ounce inches)
  (27 to 50pf) 2 to 25 mNm (.28 to 3.5 ounce inches)
  10mm 2 to 25 mNm (.28 to 3.5 ounce inches)
- Maximum axial thrust ($\Delta C \leq 0.3\%$ of C_{max}) .2 lb.
- Mounting: Can be mounted on printed-wiring boards with hole diameter min. 1.25mm (.050 inch)
- Soldering conditions: max. 260°C, max 10 sec.
-

Rated Voltage	Test Voltage (for 1 min.)	Type
150 VDC	300 VDC	5mm
250 VDC	500 VDC	7.5mm
250 VDC	500 VDC	10mm

- Contact resistance max. 10mΩ
- Insulation resistance min. 10,000MΩ
- Minimum storage temperature −55°C

SERIES 2800C/K (808)

Film Dielectric Trimmer Capacitors For Commercial And Industrial Applications

Fig. No.	Lead Configuration	Part Number	Factory Code 2222-808	Guaranteed Cap. Range Min/Max picofarads	Spindle	Adjustment Mode	Shape of Head	Dielectric Material	Temp. Coeff. PPM/°C	Minimum Q @ 1 MHz	Temp. Range Deg. C	Min. Resonant Freq. at Max Cap. MHz	Color of Base
5mm Types 150 VDC													
1	H	2805C1R505HJ	20508	1.5/5	Vertical	Top	Round	Polyprop.	−200+/−300	1000	−40 to +70	700	Grey
1	G	2805C1R505GJ	23508	1.5/5	Vertical	Top + Bottom	Round	Polyprop.	−200+/−300	1000	−40 to +70	700	Grey
1	H	2805C00210HJ	20109	2/10	Vertical	Top	Round	Polyprop.	−200+/−300	1000	−40 to +70	500	Yellow
1	G	2805C00210GJ	23109	2/10	Vertical	Top + Bottom	Round	Polyprop.	−200+/−300	1000	−40 to +70	500	Yellow
1	H	2805C2R515HJ	20159	2.5/15	Vertical	Top	Round	Polyprop.	−50+/−200	1000	−40 to +70	400	Blue
1	G	2805C2R515GJ	23159	2.5/15	Vertical	Top + Bottom	Round	Polyprop.	−50+/−200	1000	−40 to +70	400	Blue
1	H	2805C00420HJ	20209	4/20	Vertical	Top	Round	Polyprop.	−50+/−200	1000	−40 to +70	300	Green
1	G	2805C00420GJ	23209	4/20	Vertical	Top + Bottom	Round	Polyprop.	−50+/−200	1000	−40 to +70	300	Green
1	H	2805C4R527HJ	20279	4.5/27	Vertical	Top	Round	Polyprop.	−250+/−200	1000	−40 to +70	300	Red
1	G	2805C4R527GJ	23279	4.5/27	Vertical	Top + Bottom	Round	Polyprop.	−250+/−200	1000	−40 to +70	300	Red
7.5 mm Types 250 VDC													
2	M	2807C1R405MM	11558	1.4/5.5	Vertical	Top + Bottom	Round	Polyethyl.	−400+/−300	1000	−40 to +85	850	Grey
2	Y	2807C1R405YM	00004	1.4/5.5	Vertical	Top	Round	Polyethyl.	−400+/−300	1000	−40 to +85	850	Grey
2	M	2807C00209MH	00018	2/9	Vertical	Top + Bottom	Round	PTFE Teflon*	−500+/−450	1000	−40 to +85	480	Yellow
2	M	2807C00210MJ	11109	2/10	Vertical	Top +Bottom	Round	Polyprop.	−450+/−350	1000	−40 to +70	480	Yellow
2	Y	2807C00210YJ	00005	2/10	Vertical	Top	Round	Polyprop.	−450+/−350	1000	−40 to +70	480	Yellow
3	M	2807K00210MJ	17109	2/10	Vertical	Top	Hex.	Polyprop.	−450+/−350	1000	−40 to +70	480	Yellow
4	X	2807C00210XJ	51109	2/10	Horizont.	Top + Bottom	Round	Polyprop.	−450+/−350	1000	−40 to +70	480	Yellow
2	M	2807C00215MJ	11159	2/15	Vertical	Top + Bottom	Round	Polyprop.	−200+/−350	1000	−40 to +70	450	Blue
2	M	2807C00218MH	00016	2/18	Vertical	Top + Bottom	Round	PTFE Teflon*	−400+/−200	1000	−40 to +85	350	Green
2	M	2807C00222MJ	11229	2/22	Vertical	Top + Bottom	Round	Polyprop.	−250+/−350	1000	−40 to +70	350	Green
2	Y	2807C00222YJ	00006	2/22	Vertical	Top	Round	Polyprop.	−250+/−350	1000	−40 to +70	350	Green
3	Y	2807K00222YJ	17229	2/22	Vertical	Top	Hex.	Polyprop.	−250+/−350	1000	−40 to +70	350	Green
4	X	2807C00222XJ	51229	2/22	Horizont.	Top + Bottom	Round	Polyprop.	−250+/−350	1000	−40 to +70	350	Green
2	M	2807C00227MK	11279	2/27	Vertical	Top + Bottom	Round	Polycarb.	−250+/−300	200	−40 to +85	350	Red
4	X	2807C00227XK	51279	2/27	Horizont.	Top + Bottom	Round	Polycarb.	−250+/−300	200	−40 to +85	350	Red
2	M	2807C00333MJ	11339	3/33	Vertical	Top + Bottom	Round	Polyprop.	−250+/−300	1000	−40 to +70	300	Brown
2	M	2807C00340MJ	11409	3/40	Vertical	Top + Bottom	Round	Polycarb.	−100+/−300	200	−40 to +85	300	Violet
3	Y	2807K00340YJ	17409	3/40	Vertical	Top	Hex.	Polycarb.	−100+/−300	200	−40 to +85	300	Violet
2	X	2807C00340MJ	51409	3/40	Horizont.	Top + Bottom	Round	Polycarb.	−100+/−300	200	−40 to +85	300	Violet
2	M	2807C00350MJ	11509	3/50	Vertical	Top + Bottom	Round	Polycarb.	−100+/−300	200	−40 to +85	250	Black
3	Y	2807K00350YJ	17509	3/50	Vertical	Top	Hex.	Polycarb.	−100+/−300	200	−40 to +85	250	Black
4	X	2807C00350XJ	51509	3/50	Horizont.	Top + Bottom	Round	Polycarb.	−100+/−300	200	−40 to +85	250	Black

* Is a registerd trademark of E.I. DuPont de Nemours

SERIES 2800C/K (808)

Film Dielectric Trimmer Capacitors For Commercial And Industrial Applications

Fig. No.	Lead Config-uration	Part Number	Factory Code 2222-808	Guaranteed Cap. Range Min/Max pico-farads	Spindle	Adjustment Mode	Shape of Head	Dielectric Material	Temp. Coeff. PPM/°C	Minimum Q @ 1 MHz	Temp. Range Deg. C	Min. Resonant Freq. at Max Cap. MHz	Color of Base
10mm Types 250 VDC													
6	P	2810C2R515PJ	31159*	2.5/15	Vertical	Top + Bottom	Round	Polyprop	−150+/−500	1000	−40 to +70	420	Blue
5	Q	2810C2R515QJ	32159*	2.5/15	Vertical	Top + Bottom	Round	Polyprop	−150+/−500	1000	−40 to +70	420	Blue
7	U	2810C2R515UJ	61159*	2.5/15	Horizont.	Top + Bottom	Round	Polyprop.	150+/ 500	1000	−40 to +70	420	Blue
6	P	2810C00322PJ	31229*	3/22.5	Vertical	Top + Bottom	Round	Polyprop	−150+/ 400	1000	−40 to +85	200	Green
5	Q	2810C00322QJ	32229*	3/22.5	Vertical	Top + Bottom	Round	Polyprop	−150+/ 400	1000	−40 to +85	200	Green
7	U	2810C00322UJ	61229*	3/22.5	Horizont.	Top + Bottom	Round	Polyprop.	150+/ 400	1000	−40 to +85	200	Green
6	P	2810C5R540PJ	31409	5.5/40	Vertical	Top + Bottom	Round	Polyprop	−150+/ 350	1000	40 to +70	200	Grey
5	Q	2810C5R540QJ	32409*	5.5/40	Vertical	Top + Bottom	Round	Polyprop	150+/−350	1000	−40 to +70	200	Grey
7	U	2810C5R540UJ	61409	5.5/40	Horizont.	Top + Bottom	Round	Polyprop	150+/ 350	1000	40 to +70	200	Grey
6	P	2810C5R550PH	01029	5.5/50	Vertical	Top + Bottom	Round	PTFE Teflon*	500+/−150	1000	40 to +85	170	Yellow
5	Q	2810C5R550QH	01006*	5.5/50	Vertical	Top + Bottom	Round	PTFE Teflon*	−500+/−150	1000	−40 to +85	170	Yellow
6	P	2810C5R565PJ	31659*	5.5/65	Vertical	Top + Bottom	Round	Polyprop.	−200+/−300	1000	40 to +85	170	Yellow
5	Q	2810C5R565QJ	32659*	5.5/65	Vertical	Top + Bottom	Round	Polyprop.	−200+/−300	1000	40 to +85	170	Yellow
8	P	2810K5R565PJ	34569	5.5/65	Vertical	Top + Bottom	Hex.	Polyprop.	−200+/−300	1000	40 to +85	170	Yellow
7	U	2810C5R565UJ	61659	5.5/65	Horizont.	Top + Bottom	Round	Polyprop.	−200+/−300	1000	40 to +85	170	Yellow
9	U	2810K5R565UJ	64659	5.5/65	Horizont.	Top + Bottom	Hex.	Polyprop.	−200+/−300	1000	40 to +85	170	Yellow
6	P	2810C00680PK	31809*	6/80	Vertical	Top + Bottom	Round	Polycarb.	−100+/−300	200	40 to +85	170	Red
8	P	2810K00680PK	34809*	6/80	Vertical	Top + Bottom	Hex	Polycarb	−100+/−300	200	−40 to +85	170	Red
5	Q	2810C00680QK	32809	6/80	Vertical	Top + Bottom	Round	Polycarb.	−100+/−300	200	40 to +85	170	Red
8	Q	2810K00680QK	35809	6/80	Vertical	Top + Bottom	Hex	Polycarb.	−100+/−300	200	40 to +85	170	Red
7	U	2810C00680UK	61809	6/80	Horizont.	Top + Bottom	Round	Polycarb.	−100+/−300	200	−40 to +85	170	Red
9	U	2810K00680UK	64809	6/80	Horizont.	Top + Bottom	Hex	Polycarb.	−100+/−300	200	40 to +85	170	Red
6	P	2810C07100PK	31101	7/100	Vertical	Top + Bottom	Round	Polycarb.	−100+/−300	200	40 to +85	170	Violet
5	Q	2810C07100QK	32101*	7/100	Vertical	Top + Bottom	Round	Polycarb.	−100+/−300	200	−40 to +85	170	Violet
7	U	2810C07100UK	61101	7/100	Horizont.	Top + Bottom	Round	Polycarb.	−100+/−300	200	−40 to +85	170	Violet
9	U	2810K07100UK	64101	7/100	Horizont.	Top + Bottom	Hex.	Polycarb.	−100+/−300	200	−40 to +85	170	Violet

*Not for new design.

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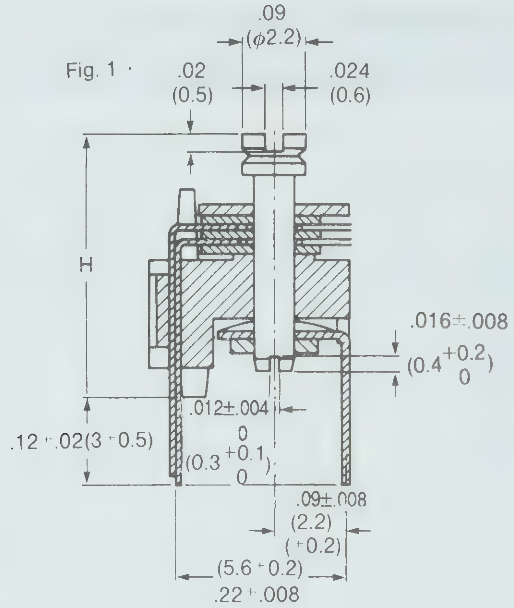
Variable Capacitors

* Is a registerd trademark of E.I. DuPont de Nemours

SERIES 2800C/K (808)

Film Dielectric Trimmer Capacitors

Fig. 1



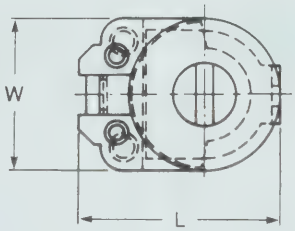


Fig. G

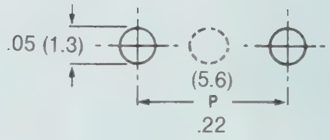
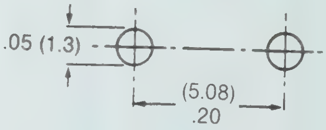


Fig. H



Cap.	H_{max}		W_{max}		L_{max}	
C_{min}/C_{max} pf	mm	inches	mm	inches	mm	inches
1.5/5	7	.276	5.5	.217	7.3	.288
2/10	7	.276	5.5	.217	7.3	.288
2.5/15	8.8	.347	5.5	.217	7.3	.288
4/20	8.8	.347	5.5	.217	7.3	.288
4.5/27	9.0	.355	6.2	.244	7.8	.307

Fig. 2

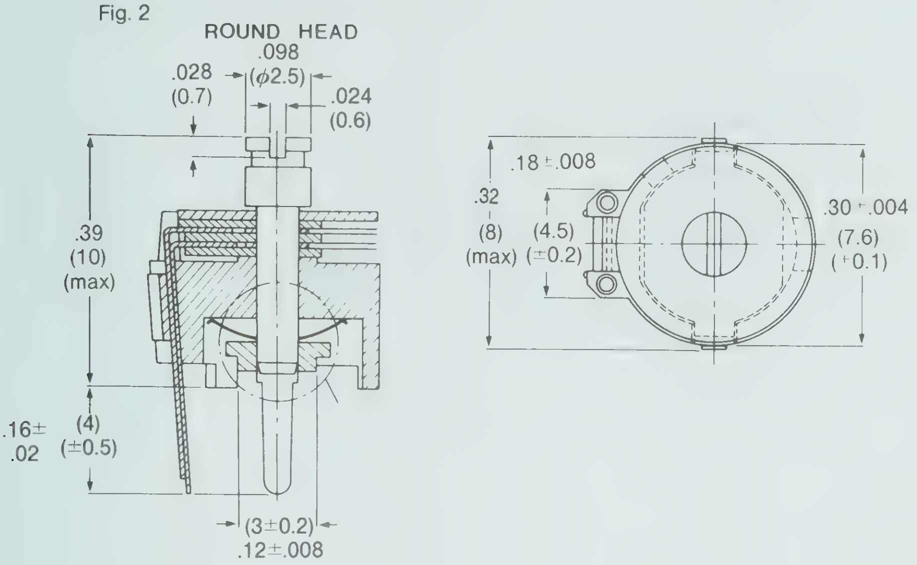


Fig. M

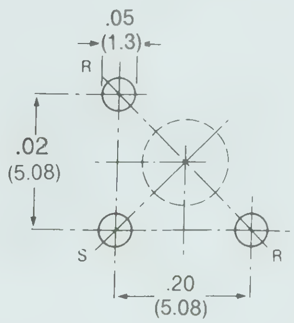


Fig. Y

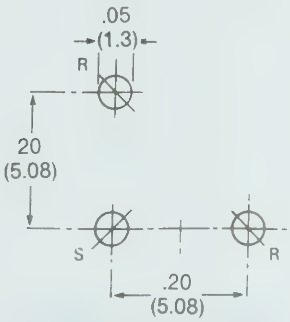


Fig. 3

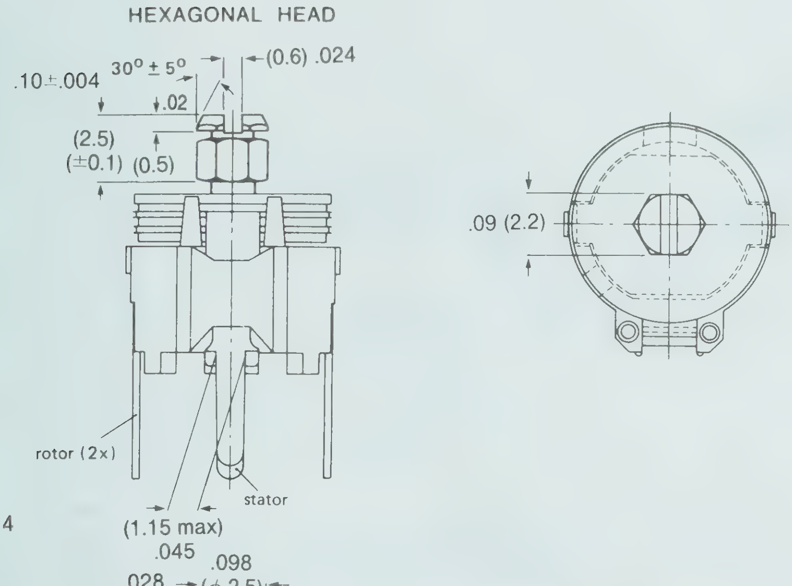


Fig. 4

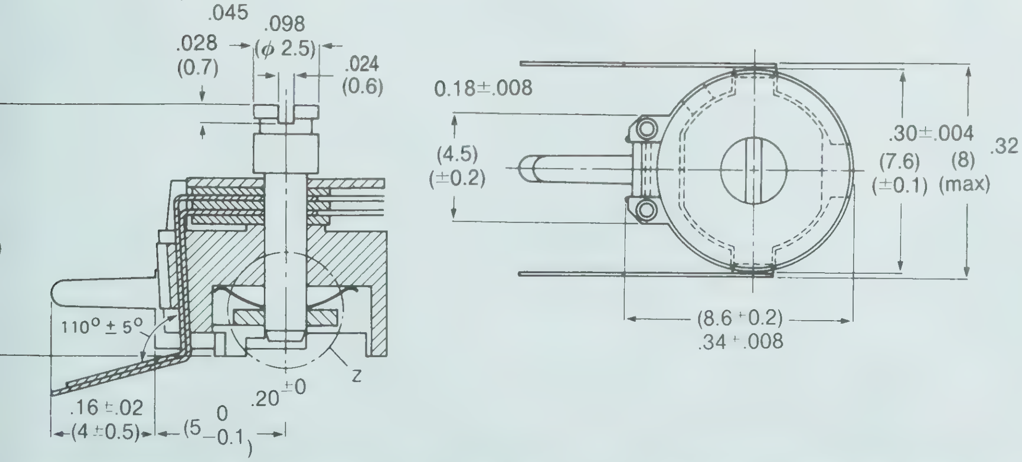
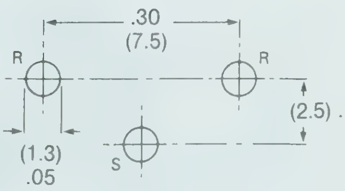


Fig. X



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Variable Capacitors

SERIES 2800C/K (808)

ROUND HEAD

Fig. 5

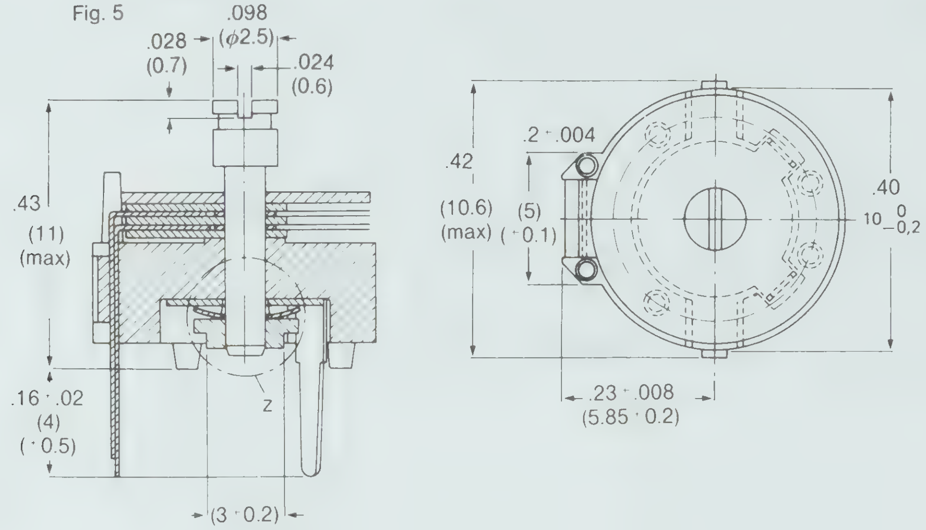
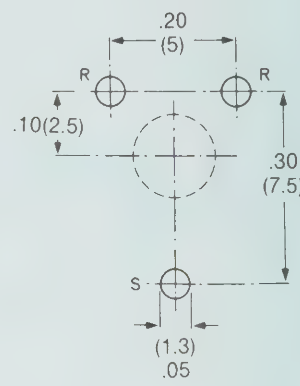


Fig. Q



ROUND HEAD

Fig. 6

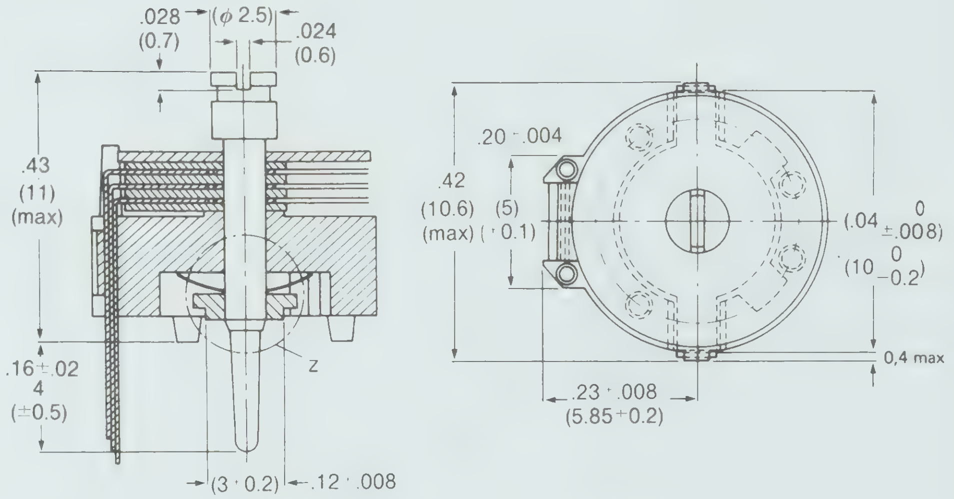
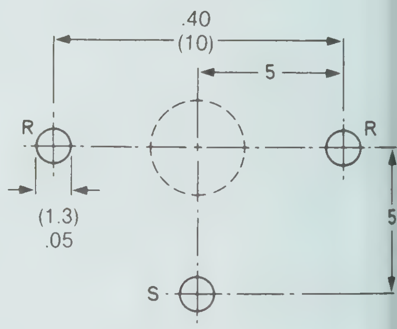


Fig. P



ROUND HEAD

Fig. 7

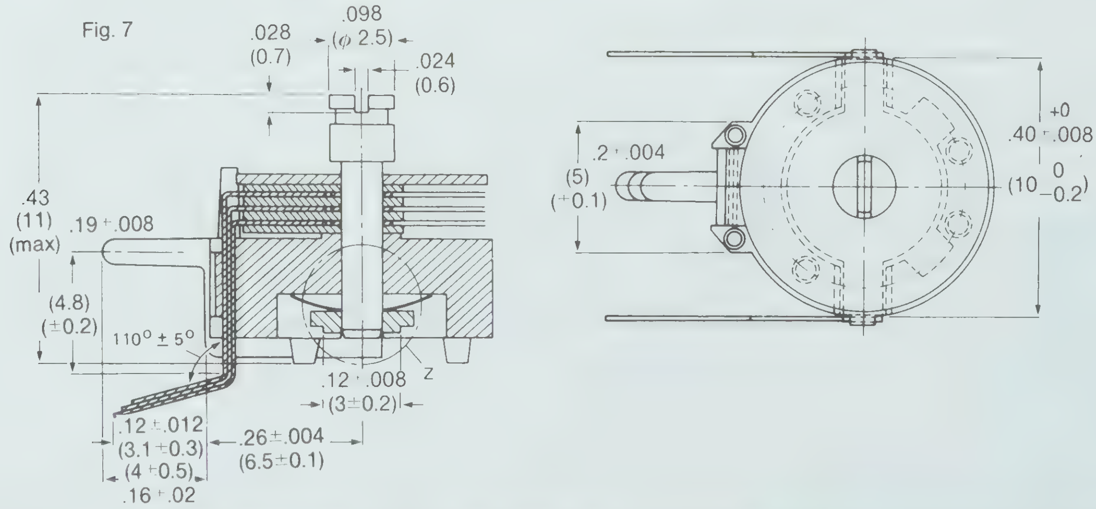


Fig. U

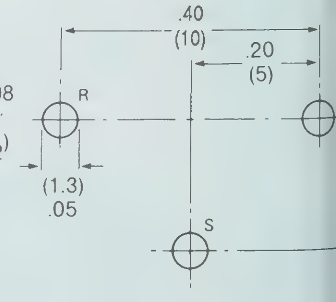


Fig. 8 EXTENDED HEXAGONAL HEAD

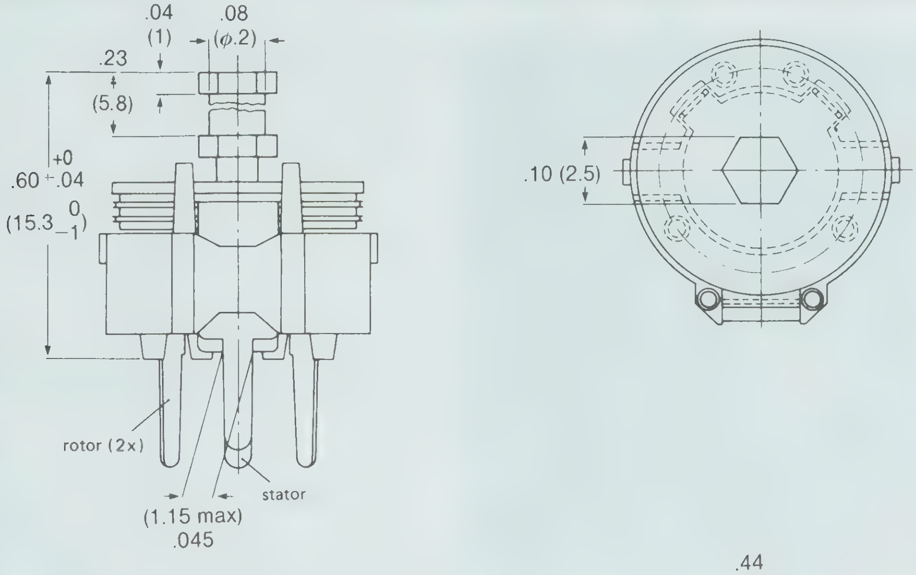


Fig. 9 EXTENDED HEXAGONAL HEAD

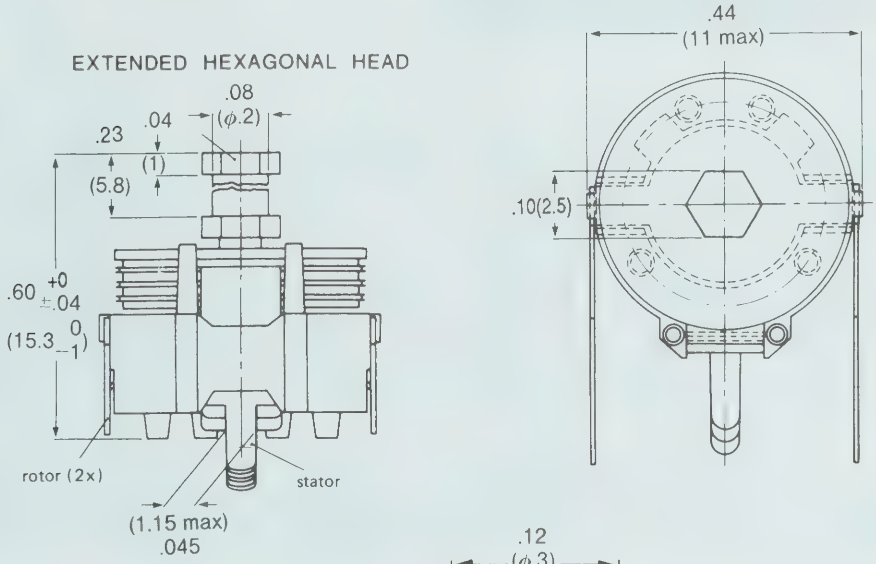
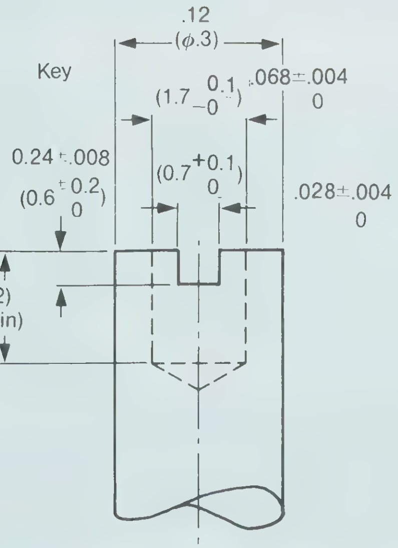
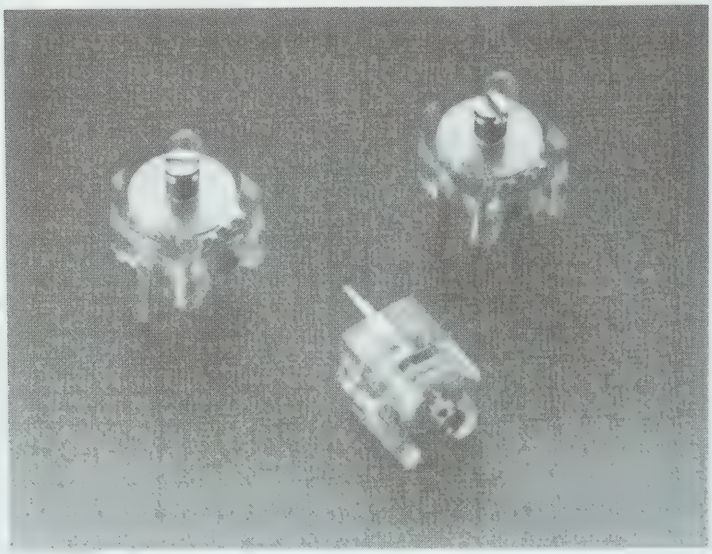


Fig. 10 Key



SERIES 2800D/E/L/M (809)

Film Dielectric Trimmer Capacitors For Professional Applications



DESCRIPTION

6mm x 8 mm x 9mm
The trimmers consist of a polysulphone housing, brass rotor and plated brass stator with a PTFE film as the dielectric. The stator plates with their tag are heat sealed to the housing. The rotor contact surfaces are plated to ensure a long life and a stable contact even under severe climatic conditions. Flux absorption between the vanes is prevented. A color dot indicates the maximum capacitance.

The trimmers have top and bottom adjustment. Top adjustment should be done by means of a screwdriver and bottom adjustment by means of the key as shown in Fig. 7.

11mm x 14mm x 9mm
The trimmers consist of a glass reinforced polysulphone frame with a polysulphone dust cover, brass rotor and stator with PTFE or polycarbonate film as the dielectric. The stator plates are stacked on pins and separated by rings, so that it is possible to produce a single-stator or a differential type. The rotor contact surfaces are plated to ensure a long life and a stable contact even under severe climatic conditions.

The trimmers have top adjustment by means of a screwdriver; capacitance increase is obtained with clockwise rotation. (Trimmers with counterclockwise rotation and trimmers with insulated rotor are available on request.)

10mm x 11mm x 11mm
The trimmers consist of a polysulphone housing, brass rotor and plated brass stator with a PTFE film as the dielectric. The stator plates with their tag are heat-sealed to the housing. The rotor contact surface is plated to ensure a long life and a stable contact even under severe climatic conditions. Flux absorption between the vanes is prevented. A color dot indicates the maximum capacitance.

The trimmers have top and bottom adjustment; top adjustment should be done by means of a screwdriver, bottom adjustment by means of the key according to Fig. 7.

8mm x 9mm x 10mm
The trimmers consist of a polysulphone housing, brass rotor and plated brass stator with a PTFE film as the dielectric. The stator plates with their tag are heat-sealed to the housing. The rotor contact surface is plated to ensure a long life and a stable contact even under severe climatic conditions. Flux absorption between the vanes is prevented. A color dot indicates the maximum capacitance.

Versions with one rotor tag and with two rotor tags are available. The trimmers have top and bottom adjustment; top adjustment should be done by means of a screwdriver, bottom adjustment by means of the key according to Fig. 7.

SERIES 2800D/E/L/M (809)

Series Dielectric Trimmer Capacitors for Professional Applications

HOW TO SPECIFY

Series 2800D Film Dielectric Trimmer Capacitors can be completely specified using the following designation:

28	05	D/E/L	1R810	B	H*****
Planar Trimmer Capacitor	Rotor Diameter 05= 5mm 08= 8mm 10=10mm	Professional Types	Capacitance Range Min. & Max. with R Denoting Decimal Point, i.e.: 1.8pf to 10pf =1R810	Lead Configuration (See mounting diagrams)	Dielectric Material H=PTFE Teflon* K=Polycarbonate

Part Number will also include 5 additional digits on end which are for internal assignments (for reference only)

FEATURES

- Effective angle of rotation: 180°
- Operating torque:
  6mm x 8mm x 9mm ($C_{max}=3.5$pf) 1 to 15 mNm (.14 to 2.1 ounce inches)
  (C_{max} = 10 and 18pf) 2.5 to 20 mNm (.35 to 2.8 ounce inches)
  11mm x 14mm x 9mm 1.5 to 25 mNm (.21 to 3.5 ounce inches)
  10mm x 11mm x 11mm 2 to 25 mNm (.28 to 3.5 ounce inches)
  8mm x 9mm x 10mm ($C_{max}=5.5$pf) 1 to 15 mNm (.14 to 2.1 ounce inches)
  ($C_{max}=9$ and 18pf) 2.5 to 20 mNm (.35 to 2.8 ounce inches)
- Maximum axial thrust ($\Delta C \leq 0.3\%$ of C_{max}) .2 lb.
- Mounting: Can be mounted on printing-wiring boards with hole diameter min. 1.25mm (.050 inch)
- Soldering conditions: max. 260°C, max. 10 sec.
-

Rated Voltage	Test Voltage (for 1 min.)	Type
300 VDC	600 VDC	6mm x 8mm x 9mm
200 VDC	400 VDC	11mm x 14mm x 9mm
300 VDC	600 VDC	10mm x 11mm x 11mm
300 VDC	500 VDC	8mm x 14mm x 10mm

- Contact resistance max. 5mΩ
- Insulation resistance between stator and rotor: min. 10,000MΩ
- Operating temperature range −40 to +125°C
  Minimum storage temperature −55°C

* Is a registerd trademark of E.I. DuPont de Nemours

5

Variable Capacitors

SERIES 2800D/E/L/M (809)

PTFE Teflon Dielectric Trimmer Capacitors For Professional Applications

Fig. No.	Lead Configuration	Part Number	Factory Code 2222-809	Guaranteed Cap. Range Min/Max picofarads	Type	Shape of Head	Dielectric Material	Temp. Coeff. PPM/°C	Minimum Q @ 1 MHz	Minium Q @ 100 MHz	Min. Resonant Freq. at Max Cap. MHz	Color Dot
6mm x 8mm x 9mm 300VDC												
1	B	2805D0R602BH	05011	0.6/2	Single-Stator	Round	PTFE Teflon *	−250+/−200	1000	500	1200	No
2	B	2805L0R602BH	05021	0.6/2	Single-Stator	Hex.	PTFE Teflon	−250+/−200	1000	500	1200	No
1	B	2805D1R203BH	05215	1 2/3 5	Single-Stator	Round	PTFE Teflon	−250+/ 200	1000	500	850	Orange
2	B	2805L1R203BH	05225	1 2/3.5	Single-Stator	Hex.	PTFE Teflon	−250+/−200	1000	500	850	Orange
1	B	2805D1R810BH	05216	1.8/10	Single-Stator	Round	PTFE Teflon	350+/ 150	1000	500	580	White
2	B	2805L1R810BH	05226	1.8/10	Single-Stator	Hex.	PTFE Teflon	−350+/−150	1000	500	580	White
1	B	2805D00218BH	05217	2/18	Single-Stator	Round	PTFE Teflon	−350+/−150	1000	400	360	Red
2	B	2805L00218BH	05227	2/18	Single-Stator	Hex.	PTFE Teflon	−350+/−150	1000	400	360	Red
11mm x 14mm x 9mm 200VDC												
3	W	2810M00212WH	07018	2/12	Differential	Slot	PTFE Teflon *	0+/−200	1000	588		*
3	W	2810E2R520WH	07004	2.5/20	Single-Stator	Slot	PTFE Teflon	0+/−200	1000	588		*
3	W	2810M2R520WH	07006	2 5/20	Differential	Slot	PTFE Teflon	0+/−200	1000	588		*
3	W	2810E00440WH	07008	4/40	Single-Stator	Slot	PTFE Teflon	0+/−200	1000	588		*
3	W	2810M00440WH	07009	4/40	Differential	Slot	PTFE Teflon	0+/−200	1000	588		*
3	W	2810E00560WH	07011	5/60	Single-Stator	Slot	PTFE Teflon	0+/−200	1000	400		*
3	W	2810M00560WH	07012	5/60	Differential	Slot	PTFE Teflon	0+/−200	1000	400		*
3	W	2810E00680WH	07013	6/80	Single-Stator	Slot	PTFE Teflon	0+/−200	1000	400		*
3	W	2810M00680WH	07014	6/80	Differential	Slot	PTFE Teflon	0+/−200	1000	400		*
3	W	2810E07100WH	07015	7/100	Single-Stator	Slot	PTFE Teflon	0+/−200	1000	400		*
3	W	2810ME07100WH	07016	7/100	Differential	Slot	PTFE Teflon	0+/−200	1000	400		*
3	W	2810M07150WK	07170	7/150	Differential	Slot	Polycarb.	0+/−200	200			*
10mm x 11mm x 11mm 300VDC												
4	Q	2810D00437QH	08002	4/37	Single-Stator	Round	PTFE Teflon *	−250+/−150	1000	400	170	Yellow
4	Q	2810D00557QH	08003	5/57	Single-Stator	Round	PTFE Teflon	−250+/−150	1000	400	150	Blue
8mm x 9mm x 10mm 300VDC												
5	N	2808D1R405NH	09004	1 4/5.5	Single-Stator	Round	PTFE Teflon *	−250+/−150	1000	666	850	Green
6	M	2808D1R405MH	09001	1.4/5.5	Single-Stator	Round	PTFE Teflon	−250+/−150	1000	666	850	Green
5	N	2808D00209NH	09005	2/9	Single-Stator	Round	PTFE Teflon	−250+/−150	1000	666	580	White
6	M	2808D00209MH	09002	2/9	Single-Stator	Round	PTFE Teflon	−250+/−150	1000	666	580	White
5	N	2808D00218NH	09006	2/18	Single-Stator	Round	PTFE Teflon	−250+/−150	1000	666	360	Red
6	M	2808D00218MH	09003	2/18	Single-Stator	Round	PTFE Teflon	−250+/−150	1000	666	360	Red

*Marking for types 11mm x 14mm x 9mm: Marked with max. capacitance value in pf, followed by the Letter E (Single-Stator Type) or the Letter D (Differential Type).

5 Variable Capacitors

* Is a registerd trademark of E.I. DuPont de Nemours

SERIES 2800D/E/L/M (809)

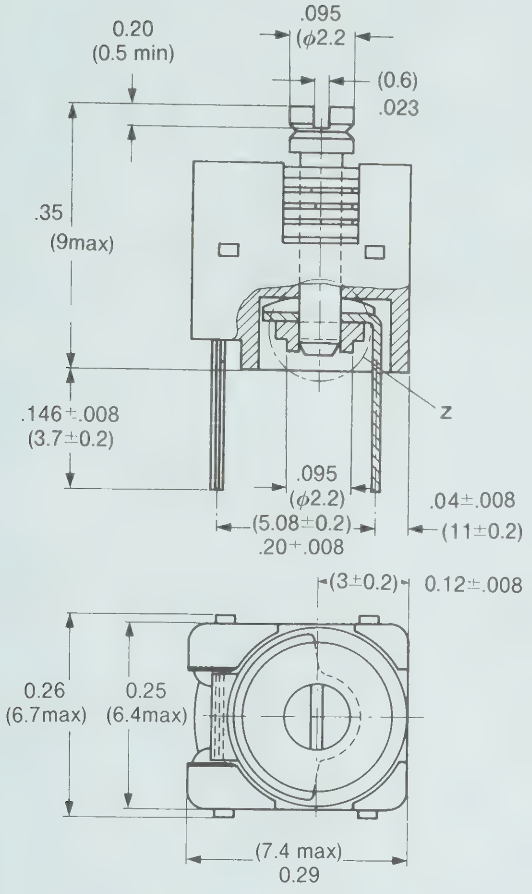


Fig. 1

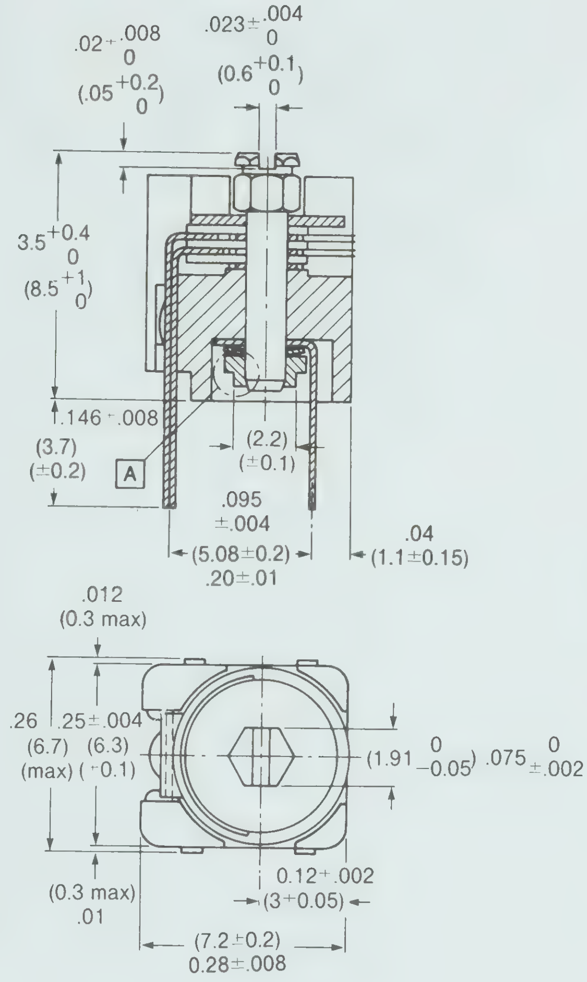


Fig. 2

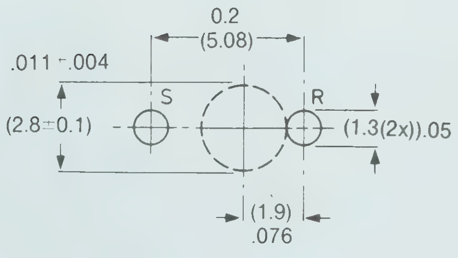


Fig. B

SERIES 2800D/E/L/M (809)

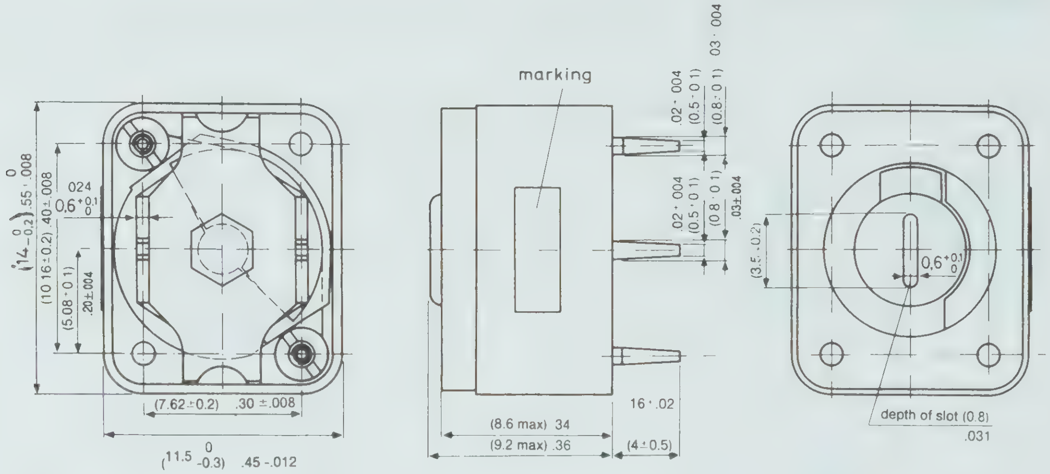


Fig. 3

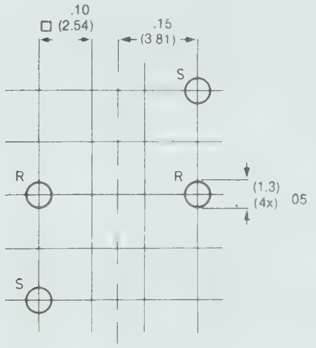


Fig. W

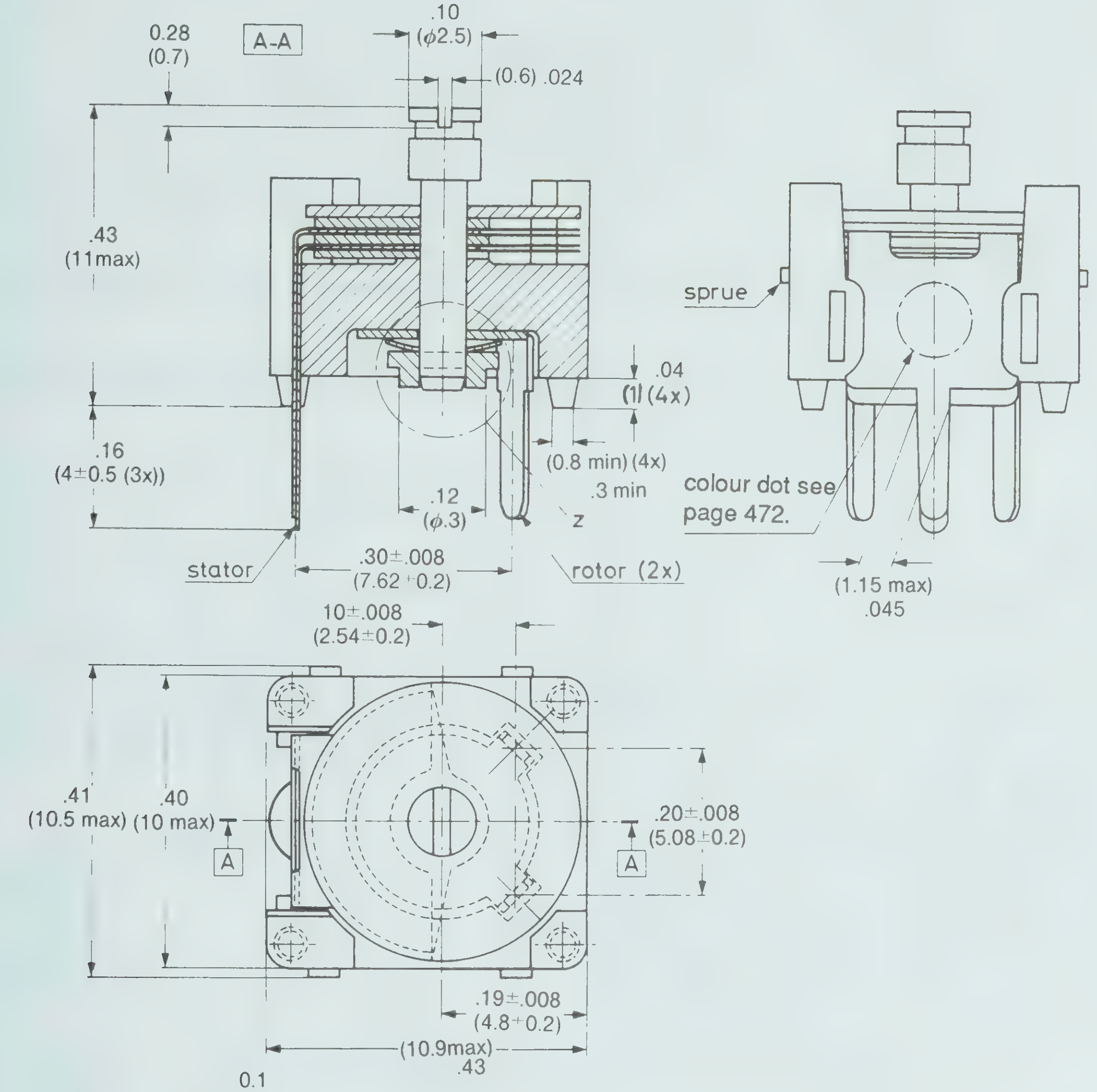


Fig. 4

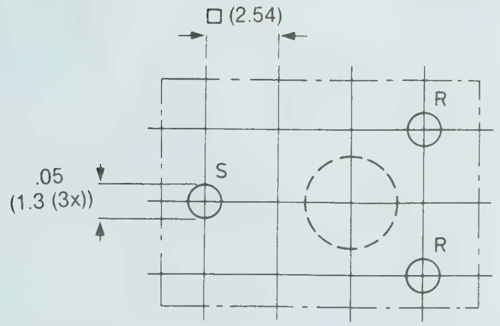
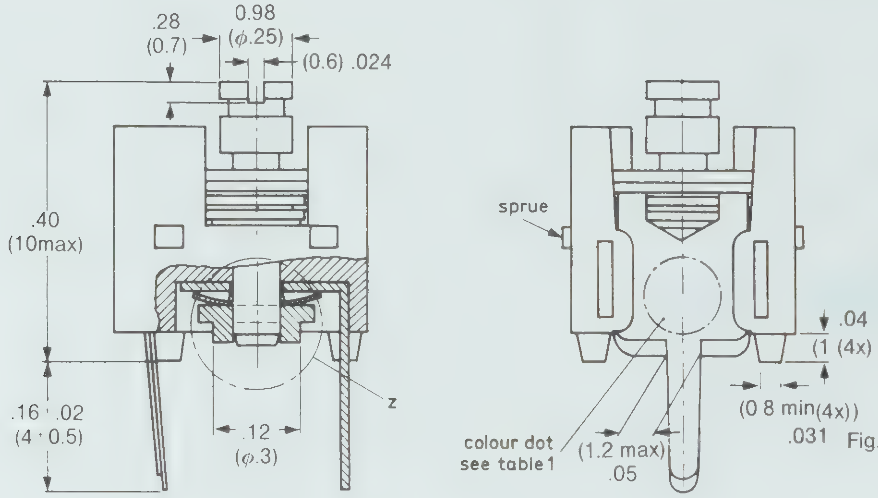


Fig. Q–Large hole is necessasry for bottom adjustment only, size user determined.

SERIES 2800D/E/L/M (809)



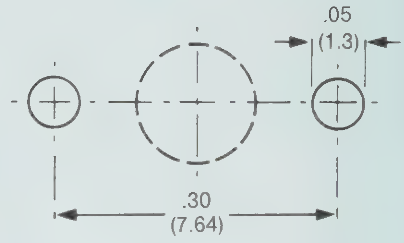


Fig. N.—Large hole for bottom adjustment, sized by user.

Fig. 5 Version with one rotor contact.

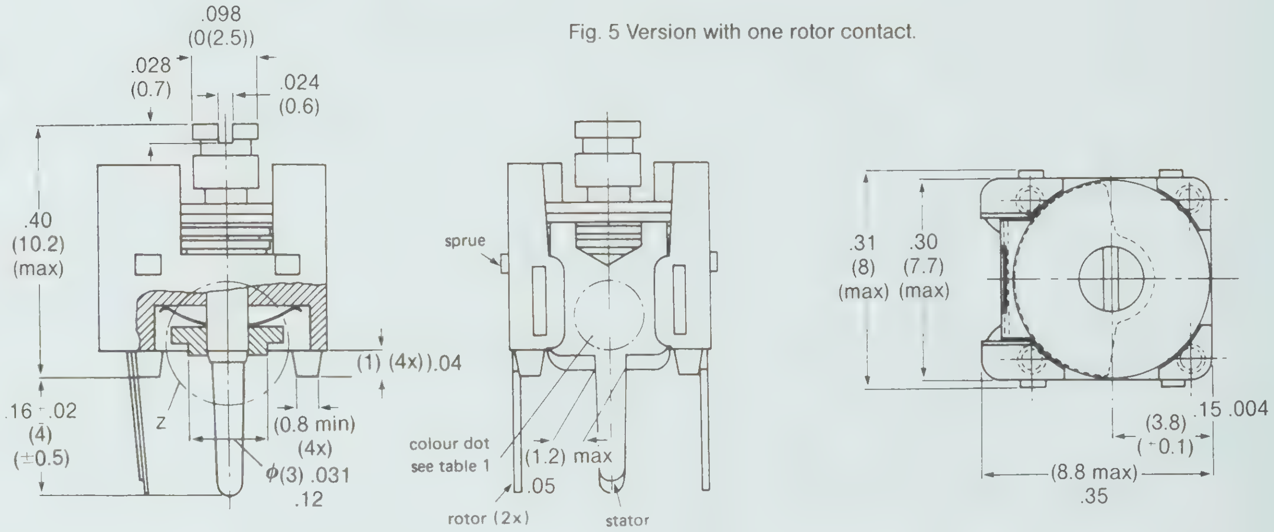


Fig. 6 Version with two rotor contacts.

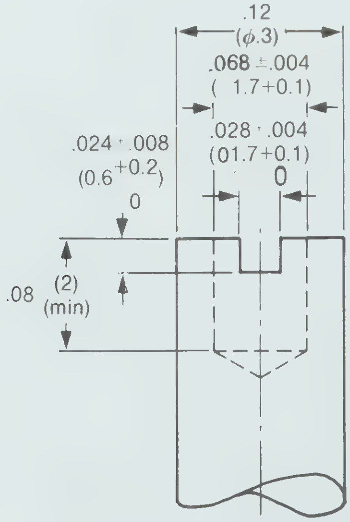


Fig. 7 Key

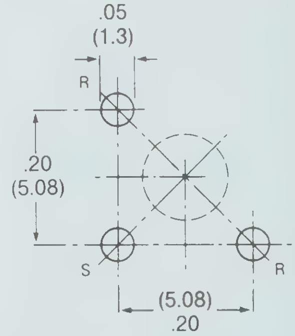


Fig. M

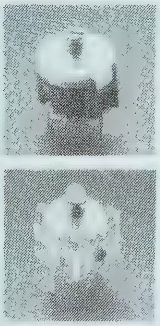
Design data for selecting and applying variable capacitors

Configurations. The variable capacitors listed in this catalog are direct-engagement, rather than screw-compression, types.

Film-Dielectric Trimmer Capacitors (Figure 1) are composed of a set of D-shaped plates rigidly mounted in a round or rectangular plastic housing, engaging a set of similar plates mounted on a central rotor shaft, interleaved with discs of plastic film dielectric. Most types are single-stator designs (Figure 2A), with a continuously rotatable rotor providing minimum-to-maximum capacitance adjustment over an effective angle of adjustment of 180°.

Series 809-070 trimmers offer a choice of single-stator (Figure 2A) or differential (Figure 2B) configurations.

The differential design provides reciprocal engagement of the rotor with two separate stators, so that the capacitance between one stator and the rotor increases, as the capacitance between the other stator and the rotor decreases, over an effective angle of rotation of 180°. In this Series, rotation of the rotor shaft is not continuous, but is limited to a maximum of 180°. In all models, connections to the rotor plates, and to all stators, are brought out as pins or tabs for direct insertion into P.C. boards.



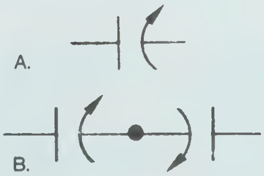


Figure 2. *Electrical Configurations*
A. Single-Stator
B. Differential

Figure 1. *Film Dielectric Trimmer Capacitor Styles*

Capacitance Limits. Even when the rotor plates in a film dielectric trimmer are competely disengaged from the stator, a measurable amount of capacitance exists between the capacitor terminals. Though small, this "zero capacitance" can be significant in some applications, and its maximum possible value is therefore given for each capacitor listed in this catalog. This value may vary slightly during a production run; for any given type, it will often be less than the rated value in the tables, but it will never be greater.

Similarly, the maximum attainable capacitance, with rotor fully engaged, will always be at least as great as the specified maximum (or the rated minimum plus capacitance swing) for any given model.

Capacitance is measured at a standard test temperature, at a standard test frequency, and at negligibly low test voltage.

NOTES: The standard test temperature for Philips Components capacitors is 25°C (77°F). Measurements at other ambient temperatures must allow for the temperature coefficient of the capacitor. The standard test frequency is 1 MHz. "Negligibly low test voltage" means that the test voltage applied is not high enough to cause significant temperature rise due to losses and leakage. Usually, at the standard test frequency, the test voltage is not critical.

Temperature Coefficient (of Capacitance). The maximum change in capacitance per unit change in the temperature of the capacitor, usually expressed in (±) parts per million of nominal per degree Centigrade. A T.C. rating is associated with a specific temperature range, over which the maximum T.C. is never exceeded.

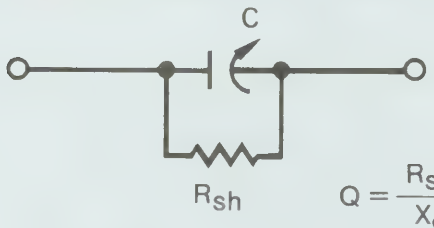
Design data for selecting and applying variable capacitors

NOTES: The temperature reference in this specification is that of the capacitor, not the ambient temperature...although, in the absence of self-heating due to losses or leakage, if the capacitor has had time to reach thermal equilibrium with the ambient, the capacitor temperature will be the same as the ambient temperature. The preferred test method is to measure capacitance (at negligible test voltage for the frequency specified) at several different temperatures, holding each temperature long enough for the capacitance to stabilize.

T.C. Tolerance. The maximum uncertainty in the temperature coefficient, expressed as a deviation in the nominal T.C. rating, over the temperature range for which the nominal T.C. was given. This tolerance indicates the variations in T.C., from unit to unit of the same model, that must be allowed for in a worst-case analysis of compensation or stabilization.

Quality Factor (Q). The ratio of the equivalent shunt resistance to the reactance of the capacitor, at a specified test frequency. Alternatively, the ratio of the reactance of the capacitor to its equivalent *series* resistance.

NOTES: The equivalent shunt (or series) resistance represents *all* the losses in the capacitor, regardless of their source, at the specified frequency. Clearly, the sources of power loss in a capacitor are *both* series-connected (e.g. lead resistance) and shunt-connected (e.g., dielectric losses), but it is assumed, in Q calculations, that all losses may be represented by a single resistor. Q is sometimes called "Storage Factor."



$$Q = \frac{R_{sh}}{X_C} = 2\pi f\, C\, R_{sh}$$

$$Q = \frac{X_C}{R_{se}} = \frac{1}{2\pi f\, C\, R_{se}}$$

Figure 4. Derivation of Quality factor.

Dissipation Factor (D). The inverse of Quality Factor, as defined above, usually expressed in percent of unity:

$$D = \frac{1}{Q}$$

$$D\,(\%) = \frac{100\%}{Q}$$

Example: for Q = 50, D = 0.02 or 2%.

DC Leakage and Insulation Resistance. The insulation resistance is the ratio of the DC test voltage impressed across a capacitor to the current that flows through it, at a specified DC test voltage and a specified capacitor temperature. The current is measured *after* the capacitor has had an opportunity to charge up to the test voltage. The leakage current is simply the current measured in the above-described test, usually with a test voltage set at the rated working voltage of the capacitor.

NOTES: The insulation resistance is not to be confused with the equivalent shunt resistance described under Quality Factors. The two are only equal at DC; at AC, the equivalent shunt resistance is lower, to account for dielectric and series losses. *Leakage is only one loss component.*

QUICK REFERENCE INDEX

INDUSTRIAL/CONSUMER GROUP

Philips Components Series	Category	Body Type	Resistance Range (ohms)	Tolerance Range (±%)	Temperature Coefficient Range (PPM/°C)	Power Range @70°C (watts)	Max. Voltage Range (volts)	Page
SPACE MISER®	GENERAL PURPOSE	METAL FILM Conformal Coated	22Ω-10Meg 10Ω-10Meg	5% 1%	±100 ±100	⅓ ⅓	200 200	482
CR	GENERAL PURPOSE	CARBON FILM Conformal Coated	1Ω-10Meg	5%	−200 to +500 ±300	¼ ½	250-350	488
SFR	GENERAL PURPOSE	METAL FILM Conformal Coated	1Ω-10MegΩ	1%-2% 5%	±200 & ±100	¼ ½	250-350	490
PR	POWER FILM	METAL FILM Conformal Coated	1R-1Meg	±5%	±250	1 2 3	350 500 700	497
VR	HIGH VOLTAGE/ HIGH VALUE	CERMET FILM Conformal Coated	100K-220Meg	±5%	±200	¼,½,1	to 10KV	499
NFR	FUSIBLE/ FLAMEPROOF	METAL FILM Conformal Coated	1Ω-15KΩ	±5%	±100 ±200	¼,⅓,½	350 500	501
SFR ZERO OHM JUMPER WIRE	Jumper Wire	N/A	.001Ω Max	N/A	N/A	1/16-1	500	503
SPR (5000Y)	STANDARD PRECISION	METAL FILM Conformal Coated	1Ω-1Gig	0.5%-5%	Ω50 to	¼-1	250-504	504
UPR & MATCHED SETS (5000Z)	ULTRA PRECISION	METAL FILM Conformal Coated	51.1Ω-511K	0.02%-1.0%	±5 to ±25	1/20–⅓	200-300	507 512
PPR	PRECISION POWER FILM	METAL FILM Conformal Coated	5Ω-100K	.05%-1%	± to ±100	(@25°C) 1-5	160-500	509

INDUSTRIAL/STANDARD MILITARY

MIL Style	MIL Spec	Body Type	Resistance Range (ohms)	Tolerance Range (±%)	Temperature Coefficient Range (PPM/°C)	Power Range @70°C (watts)	Max. Voltage Range (volts)	Page
RL (5000T)	MIL-R-22684	METAL FILM Conformal Coated	4.3Ω-470KΩ	2% 5%	±100	¼–½	250-350	513
RN (5000R/M)	MIL-R-10509	METAL FILM Conformal Coated	1Ω-4M	0.1%-1%	±25 ±100	⅒–½	200-350	511,515

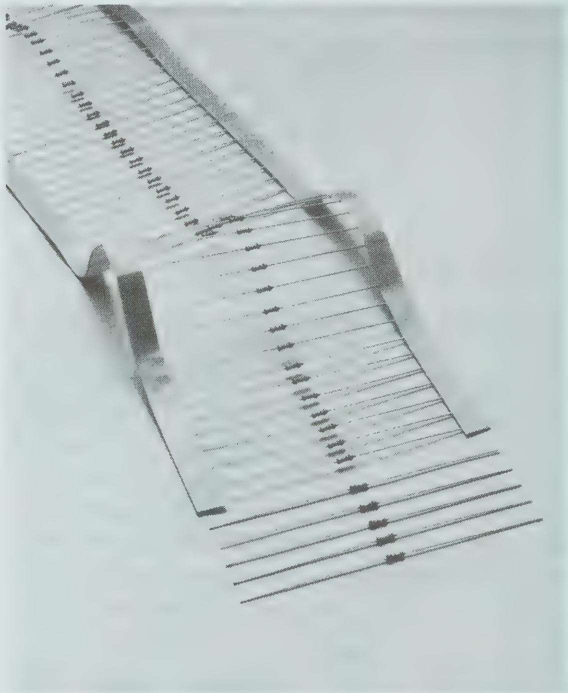
ESTABLISHED RELIABILITY (MIL)

RLR (5000U)	MIL-R-39017	METAL FILM Conformal Coated	4.3Ω-1.33Ω	1%-2%	±100	⅛–½	200-350	518
RNC (5000V)	MIL-R-55182	METAL FILM Conformal Coated	10Ω-3.01M	0.1%-1%	±25 to ±100	@+125°C 1/20–¼	200-300-	520
RNR (5000A)	MIL-R-55182	METAL FILM Hermetic Seal	10Ω-1.21M	0.1%-1%	±25 ±50	@+125°C ⅒–¼	200-300-	522
PACKAGING INFORMATION FOR PHILIPS COMPONENTS RESISTORS								525
DESIGN DATA FOR SELECTING AND APPLYING FILM RESISTORS								526

SPACE MISER®

5063J Metal Film Resistor

1% & 5% Tolerances
100 PPM/°C T.C.R.
Power Rating
1/3 Watt @ 70°C for 10,000 Hr. Operating Life
1/4 Watt @ 70°C for 225,000 Hr. Operating Life



6

Fixed Resistors

DESCRIPTION

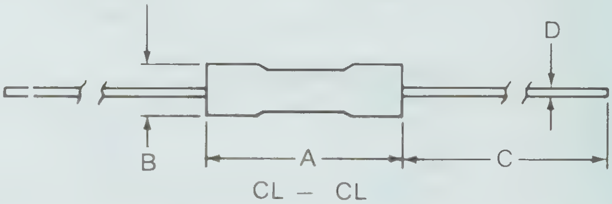
Philips Components and Beyschlag of West Germany combine to offer general purpose metal film resistors suitable for high density packaging. The 5063J Space Miser dissipates 1/3 Watt in a package the size of the smallest 1/8 watt.

In addition to the small size, the 5063J Space Miser offers the outstanding electrical characteristics—low noise, low reactance, stability, temperature coefficient—of a truly superior metal film resistor.

The 5063J Space Miser features a high alumina core for superior mechanical strength and heat dissipation; 0.020 in leads for ease of auto insertion and heat dissipation; inline pulse testing for reliability enhancement; and an effective coating system for solvent and environmental protection.

FEATURES

- Designed for High Density Applications
- Capable of Automatic Insertion on as Close as .200 in (5.08mm) Centers
- 1/3 Watt (No Power Sacrifice While Downsizing)
- Tape and Reel & Ammo Packaging for Automatic Insertion
- Exceeds the Stability Requirements of Mil-R-10509
- 100% In-Line Reliability Testing
- Excellent Pulse-Handling Characteristic



SPECIFICATIONS

P/N	Resistance Tolerance	Resistance Range (ohms)*	T.C.R.	Max Voltage (VRMS)	A Max (mm)	B Max (mm)	C Max (mm)	D Nom (mm)
5063J	±5% ±1%	.22-10 MEG 1-10 MEG	±100 ±100	200 200	0.142 in. (3.6)	0.063 in. (1.6)	1.1 in. (29)	0.020 in. (.5)

Power Rating at 70°C—1/3 Watt for 10,000 hour life; 1/4 watt for 225,000 hour life.

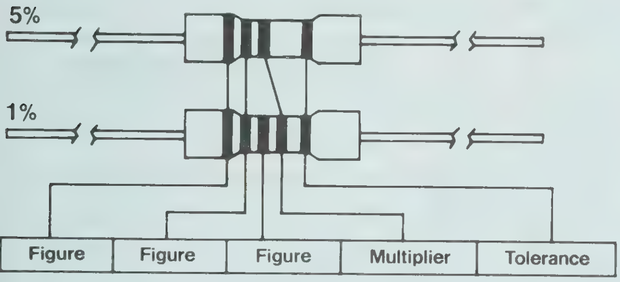
* The 5063J is also available as a zero ohm resistor.

PERFORMANCE SPECIFICATIONS COMPARISON

Test	% Change in Resistance (△R)				
	5063J Tolerance		Mil-R-39008 Style RCR Requirement	Mil-R-22684 Style RL Requirement	Mil-R-10509 Style RN Requirement
	1%	5%			
Temperature Cycling, −65°C to +150°C	±0.25%	±0.25%	4.0%	1.0%	0.5%
Low Temperature Operation, −65°C	±0.25%	±0.25%	3.0%	0.5%	0.5%
Short Time Overload	±0.25%	±0.25%	2.5%	0.5%	0.5%
Terminal Strength, 5 lb. pull	±0.2%	±0.2%	1.0%	0.5%	0.2%
Resistance to Soldering Heat, +350°C	±0.25%	±0.25%	3.0%	0.5%	0.5%
Moisture Resistance, Mil Std 202	±1%	±1%	15.0%	1.5%	1.5%
Life 1000 hrs (1/3 watt)	±0.5%	±1%	—	—	—
Life 1000 hrs (1/4 watt)	±0.25%	±0.7%	—	—	—
Life 1000 hrs (1/8 watt)	±0.15%	±0.4%	10.0%	2.0%	1.0%
Shock, 50G, 11ms	±0.25%	±0.25%	—	0.5%	0.5%
Vibration-High Frequency, 10-2000Hz	±0.25%	±0.25%	2.0%	0.5%	0.5%

95% of parts tested had smaller changes than indicated.

PART MARKING



Color	Figure	Multiplier	Tolerance
Black	0	1	—
Brown	1	10	1%
Red	2	100	—
Orange	3	1K	—
Yellow	4	10K	—
Green	5	100K	—
Blue	6	1M	—
Violet	7	—	—
Gray	8	—	—
White	9	—	—
Gold	—	.1	5%
Silver	—	.01	—

HOW TO SPECIFY

5063J Resistors can be completely specified using the following designation:

50 6 3 J D 270KO F

- **50** — **Fixed Resistor Axial Lead**
- **6** — **Power Rating** 1/3 Watt
- **3** — **Encapsulation Style** 3 = Conformal
- **J** — **Style** J = MBA
- **D** — **Temperature Coefficient** D = ±100 PPM/°C
- **270KO** — **Resistance Value** R—ohm, K—1,000 ohm, M—1,000,000 ohm, 49R90 = 49.9Ω, 499R0 = 499Ω, 1K000 = 1KΩ, 1M000 = 1 megΩ
- **F** — **Resistance Tolerance** F = ±1%, J = ±5%

6 Fixed Resistors

SPACE MISER®

5063J Metal Film Resistor

Application Guidelines

PREFACE

A resistor is a simple device. So why are we issuing an applications guide?

One reason is that film resistors really aren't quite so simple. For example, the materials selection is critical. Materials must be matched for thermal expansion characteristics, for chemical compatibility under a variety of ambient conditions, and for stability with time and temperature. Plus the processes involved in the manufacture of a resistor are quite sophisticated. Many processes used in IC or hybrid production were developed for, or first used for, discrete resistors.

A second reason is that pure, absolute resistance exists only in textbooks. All resistors have some degree of capacitance and/or inductance. All resistors are, to some degree, unstable with time, temperature and load.

Our third reason is that, as in the development of any product, the design and manufacture of the 5063J resistor involves a number of technical alternative decisions which impact your application of the product.

To simplify the introduction of the 5063J, we have presented a series of questions and answers related to each major application factor. In developing the answers, we have tried to include some of the reasoning behind the design alternative decisions.

We may not have answered the question in your mind or we may not have provided enough detail. If not, give us a call and we'll do our best to help you.

POWER RATING

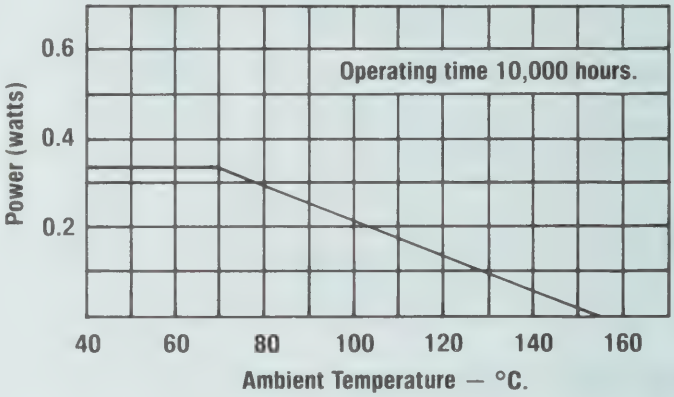
The power rating indicates the maximum power that can be dissipated continuously at a specified ambient temperature with the "hot spot" temperature not exceeding a specified maximum temperature.

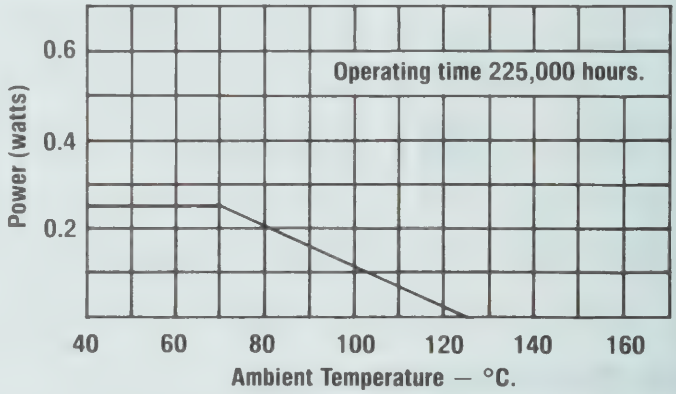
By lowering the "hot spot" temperature, the resistance change over time can be reduced and the useful life of the resistor extended.

Power Rating @70°C	Resistance Value (ohms)	Hot Spot Temperature (°C)	Max % △R vs. Time		
			1000 Hrs.	10000 Hrs.	225000 Hrs.
1/3 Watt	10 to 100K	155	0.50	1.10	—
1/4 Watt	10 to 100K	125	0.25	0.55	1.60

POWER DERATING

The 5063J Space Miser can be operated at ambient temperatures higher than 70°C, provided the dissipated power rating is reduced per the following curves.





Q. How can the 5063J be rated as a ⅓ watt when it's only a ⅛ watt body size?

A. First, there is an historical aspect to the size vs. power rating question. In the U.S. in the late 1950's, when the first metal film resistor specifications were being written, it was deemed desir-

able to have the film resistor the same size as a carbon composition of the same power rating, even though the thermal characteristics were quite different.

So when we say that a resistor is a "⅛ watt size", one meaning is that it is the size set by the military originally for carbon composition for ⅛ watt dissipation. In actuality, the ability of a resistor to dissipate power is a function of (1) the temperature hardness of the materials used and (2) the efficiency of heat transfer to the world outside the resistor. Size is, of course, a factor, but for film resistors, not the most important one.

The 5063J was designed specifically to be able to dissipate maximum power in the minimum size to allow downsizing without electrical redesign.

Q. Why the double (1/3 & 1/4 watt) ratings and how are they to be used?

A. We divided applications into normal and long-term classifications. A "normal" application is defined as one where the useful operating life of the equipment is 10,000 hours or less. An example would be an automobile. The life of an auto is estimated as 100,000 miles at an average speed of 20 miles/hour or 5,000 hours.

The definition of "long-term" is 225,000 hours operation. An example of this kind of application would be telephone switch gear, which is in continuous operation for many years.

Since the resistor is not required to "last" as long in a normal application, it can be rated higher, with a higher operating temperature. Conversely, for the long-term application, the operating temperature must be lower to extend the life of the resistor.

Application	Surface Temperature (ambient of 70°C)	Life
Normal	155°C	10,000 Hrs
Long-term	125°C	225,000 Hrs

Q. How does the 5063J differ from other film resistors?

A. Let's look at how the 5063J is constructed and how it functions thermally. The mechanics are simple—a ceramic rod is coated with a thin film of various resistive alloys, end caps are press-fitted, the film is cut in a helix around the cylindrical rod to increase the resistance, leads are welded to the end caps, the body is coated for environmental protection and the body is color banded for identification.

The electrical energy is converted to heat in the resistive film. The heat is then conducted to the outside (using air as the immediate environment) by two primary paths:

1. FILM → CORE → CAP → AIR
↳ LEAD → AIR
↳ PCB → AIR

2. FILM → COATING → AIR

To optimize the heat transfer, the 5063J has several interesting features:

(1) The core material is a specially developed, high alumina, highly thermally-conductive formulation which improves the transfer of heat from the core through the core to the cap.

(2) The bottom of the end cap is uncoated, which increases the area of metal to air surface exposure.

(3) The 5063J has larger leads. Most resistors of this size have .016″ diameter leads while the 5063J has .020″. This increases the metal to air surface area and, more importantly, as heat transfer is proportional to cross sectional area of the lead, increases the heat transfer to the printed circuit board by a factor of 1.56.

(4) The coating on the 5063J is thinner than normal. The most important role of the coating is to protect the resistor from adverse environments—abrasion and humidity primarily—and to isolate the resistor electrically.

Unfortunately, the materials which do this best are also good thermal insulators, so that heat transfer along the second path cannot be maximized without compromising the main purpose of the coating. A proprietary coating has been developed for the 5063J which will perform the primary function of protection and isolation with a minimum thickness.

MOUNTING

Packaged to allow use of standard auto insertion equipment (Ammo pack or reel).

.200 in. centers possible (leads bent at right angles).

Rugged construction with high alumina core prevents breakage.

0.020 in. leads provide easier handling by automatic insertion equipment.

Color banding for ease of on-board identification.

SPACE MISER®

5063J Metal Film Resistor

Q. Because of the unique design, are there any special precautions which need to be taken in the application of the 5063J?

A. Possibly. Remember, the body temperature of the 5063J at maximum dissipation and ambient temperature is 155°C so check the temperature rating of the printed circuit board. If your application is at maximum dissipation and ambient temperature with minimum spacing, the solder joint temperature may also be critical.

RELIABILITY

100% inline pulse test to eliminate infant mortality.

High alumina core and 0.020" leads provide a "cooler" hot spot at any given wattage than other resistors of the same size for longer life.

In use failure rate of .00007%/1000 hrs.

Manufactured under CECC quality assessment program.

Q. What is Philips Components' position on Quality of the 5063J?

A. Although Mepco/Centralab doesn't manufacture the 5063J, we back the product exactly as though we did.

Before offering this product, we conducted an extensive evaluation in our own test facilities, using the same equipment and procedures we use to test Philips Components products to the Established Reliability Specifications. We found the performance to be excellent. A summary of this test is an addendum to this guide.

We have visited Beyschlag to review the manufacturing facilities and to talk with their technical, quality and management people. The Beyschlag organization is of the finest caliber. (We believe we should know because we're not exactly new to this business.)

Beyschlag has earned an international reputation for superior quality—that's one reason we joined with them in offering this product.

Q. What is the inline pulse test?

A. The inline pulse test consists of
[a] reading of the resistance;
[b] loading the resistor with a maximum pulse of 50 times the rating;
[c] reading the resistance;
[d] calculating the change in resistance;
[e] eliminating any resistors which change more than a specified amount.

The initial resistance reading establishes the norm for that resistor. If the resistor has a critical defect or flaw, the pulse applied will induce a change in resistance. The second reading measures that change and compares it to a standard for expected change. If the standard is exceeded, the resistor is rejected.

Q. What is the "in use failure rate"?

A. This is the maximum estimated failure rate at 60% confidence, valid for resistances from 10 to 100,000 ohms, mounted in equipment after the equipment has left the equipment test area.

Q. The 5063J is manufactured under the CECC Quality Assessment Program. What exactly does that mean?

A. CECC stands for the CENELEC Electronic Components Committee. CENELEC is the European Committee for Electrotechnical Standards. This is a European International standardization and Quality Assessment group with the power to grant a Mark or Certificate of conformity.

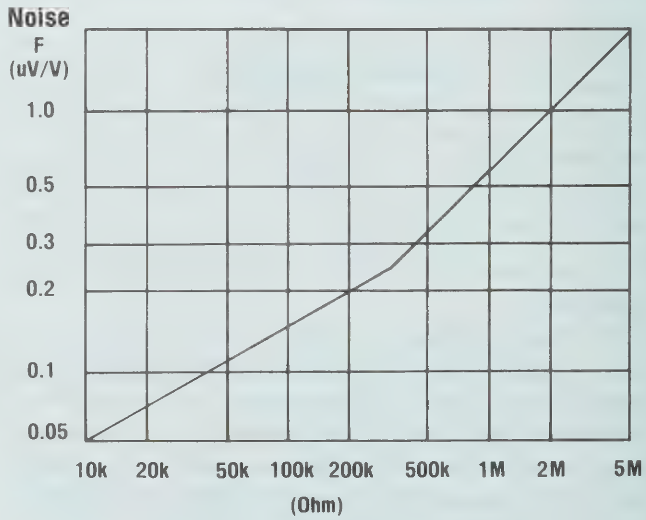
CURRENT NOISE

Current noise is generated by the passage of current through the resistive material. It is inversely proportional to frequency and proportional to the square of the current.

In addition to the above general relationships, current noise depends greatly on materials, design, manufacturing techniques and resistance value.

Noise index is the ratio of current-noise voltage to average DC voltage produced by a specified current, measured over a one-decade frequency bandwidth and is expressed in microvolts/volt.

The following chart presents the maximum value of 95% of the population.



6

Fixed Resistors

Q. Why is noise considered important?

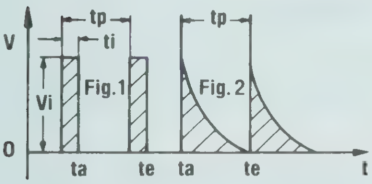
A. In addition to the obvious concern that a low level signal may get lost in the noise, noise is an indication of the reliability of the resistor. The same defects which can cause failure of the resistor most likely will make the resistor noisy.

Q. What types of defects cause noisy resistors?

A. Generally, defects which can intermittently impede current flow, such as flaws in the core, film defects and helixing flaws.

PULSE LOAD RATING

■ Instantaneous power can be higher than that shown by the derating curve provided the following conditions are observed:



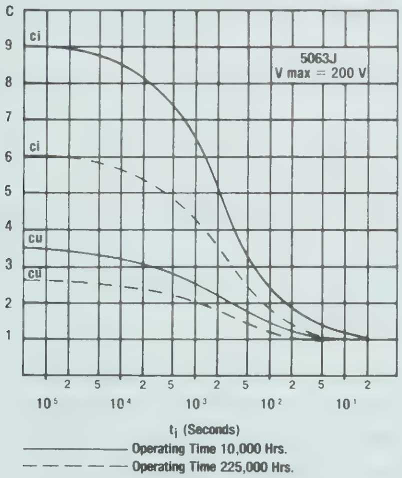
Following conditions must be fulfilled simultaneously:

$$\frac{1}{t_p R} \int_{ta}^{te} Vi^2 dt \leq P_T \quad (1)$$

$$|V_i| \leq ci \sqrt{P_T \cdot R} \quad (2)$$

$$|V_i| \leq cu \cdot V_{max} \quad (3)$$

P_T: Permissible constant load at a given ambient temperature T



Q. What do these conditions mean?

A. The first equation in essence says that the average power over the duration of one pulse cycle must not exceed the rated power. The second limits the peak voltage to a multiple of the rated voltage for the resistance under test, while the third places a further restriction on the voltage by limiting it to a multiple of the maximum continuous voltage. The multiples are a function of the duration of the pulse and are given in the graph.

EXAMPLE: Pulse load rating for long-term operation.

GIVEN: R = 100 Ohms
T = 70°C
Vi = 25 V (square wave)
ti = 0.2 ms
tp = 0.1 sec

LIMITS: P_{70} = 0.25 watt
V_{max} = 200 V

FROM GRAPH: cu = 2.4, ci = 5.4

CONDITION 1:

$$\frac{1}{0.1 \times 100\ \text{ohm}} \int_0^1 (25V)^2 \times 0.0002\ \text{sec} =$$

0.0125 Watt ≤ 0.25 Watt

CONDITION 1 - OK

CONDITION 2:

$$25V \leq 5.4\sqrt{0.25\ \text{Watt} \cdot 100\Omega} \leq 25V$$

CONDITION 2 - OK

CONDITION 3:

25V ≤ 2.4 • 200V ≤ 480

CONDITION 3 - OK

REACTANCE

The reactance of the 5063J is primarily capacitive. (There may be some inductance at very high frequencies on small ohmic values, but it will be low.)

Because the reactance of film resistors is small, it is very difficult to measure. External factors such as length of leads, layout of the circuit, environmental stray capacitance, measuring equipment, etc. may have a significant effect on the measured value.

When measured with a Hewlett Packard 4720A automatic capacitance bridge, the 5063J displays the following characteristics:
(a) floating connections: C=0.15 to 0.20 pF
(b) one side grounded connections: C<0.5 pF
The capacitance was independent of resistance value and frequency up to 1 MHz.

Q. How does this compare to other film resistors?

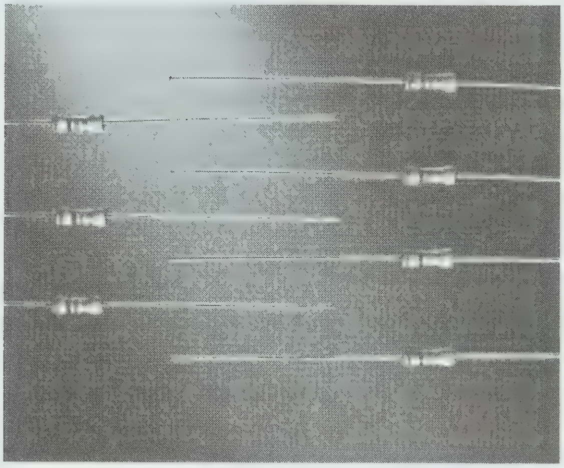
A. The reactance of film resistors is primarily dominated by the cap to cap capacitance so that resistors of the capped construction and same physical size will have about the same reactance.

6

Fixed Resistors

CR SERIES

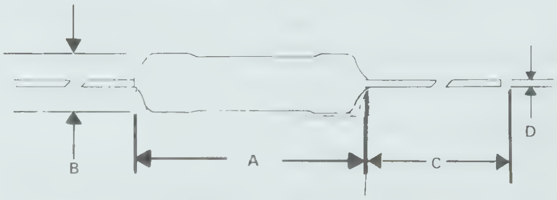
Industrial/Consumer Conformal-Coated
5% Tolerance
1/4, and 1/2 Watts (70°C)
Carbon Film Resistors



DESCRIPTION

CR Series resistors are the highest-performance, highest-reliability low-cost carbon-film resistors available at the current state of the resistor art. They are particularly well suited to those applications that require significantly better performance than can be obtained with carbon-composition resistors, and offer a simultaneous reduction in cost as well. These resistors feature very low noise, excellent stability, and wide operating frequency range, in minimum size for their power ratings.

DIMENSIONS



DESIGN FEATURES

- Highest Carbon-Film Temperature and Time Stability, approaching those of industrial metal-film resistors.
- Low Voltage and Power Coefficients, approaching those of metal-film resistors of comparable size.
- Lowest Noise Index Ever Attained in Carbon-Film.
- Very Low Reactance—negligible series L, very low shunt C; reactance error is generally less than tolerance up to 10MHz, for most resistance values.
- Excellent Immunity to Environmental and Electrical Stress. Highest reliability, longest stable life of any design in this class.
- Most Compact Construction in this class.
- Very Durable Design. Especially well suited to automatic assembly, wave soldering, conveyorized handling. Easily withstands industrial solvents used in cleaning circuit assemblies

SPECIFICATIONS & NOMENCLATURE

Philips Components P/N (Type)	Power Rating (70°C)	Resistance Range (Ohms)*	Resistance Tolerance	Max. Voltage (Volts)	Dimensions Inches (mm)—see diagram			
					A Max.**	B Max.	C	D
5043CX-J (CR25)	1/4W	1Ω-10 Meg	±5%	250	0.268 (6.8)	0.098 (2.5)	1.102±.079 (28±2)	0.024 (0.6)
5053CX-J (CR37)	1/2W	1Ω-10 Meg	±5%	350	0.393 (10)	0.145 (3.7)	1.102±.079 (28±2)	.024 (0.6)

*Within the resistance ranges shown, the available resistance values are indicated in the MIL 10 to 100 decade table of values (see table page 525), and their decade multiples.

**Maximum run off on lead is 1 MM max. (0.039") when both sides are added together.

6 Fixed Resistors

CR SERIES

Industrial/Consumer Conformal-Coated Carbon Film Resistors

PERFORMANCE CHARACTERISTICS

SPECIFICATIONS	1/4 W	1/2 W
Power rating P_{nom} at 70°C	0.25W	0.5W
Maximum voltage AC or DC	250V	350V
Voltage (RMS) that may be applied for 1 sec. across insulated coat	500V	700V
Insulation resistance	10^4MΩ	10^4MΩ

	ALL TYPES
Ambient temperature	−55 to +155°C
Temperature coefficient	see figure 2
Noise voltage	see figure 1

Dielectric Withstanding Voltage
2x limiting voltage for 1 min. between terminals of resistor and metal foil .... no breakdown or flashover

MARKING
CR series resistors are marked using four color bands, per EIA specification RS-196A.

PACKAGING
Available in Bulk (100 pieces per box) or Tape and Reel (5000 pieces per reel).

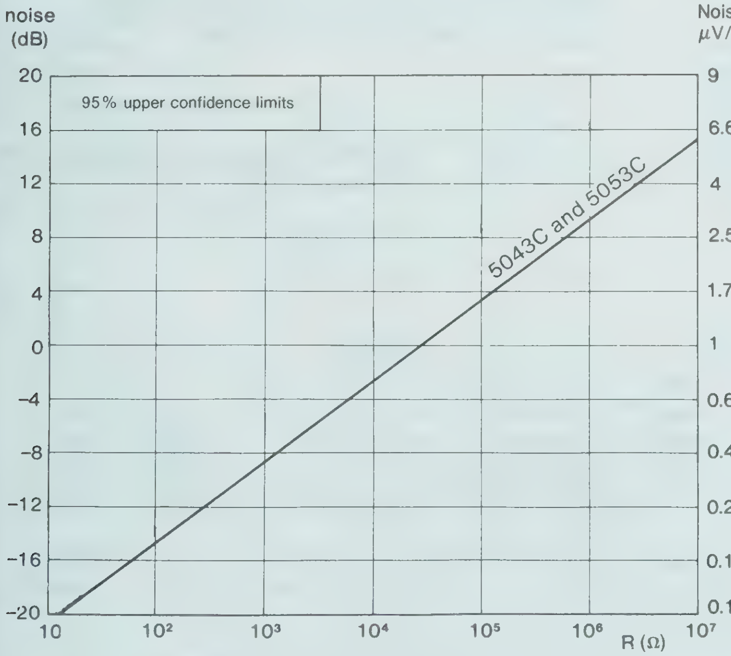
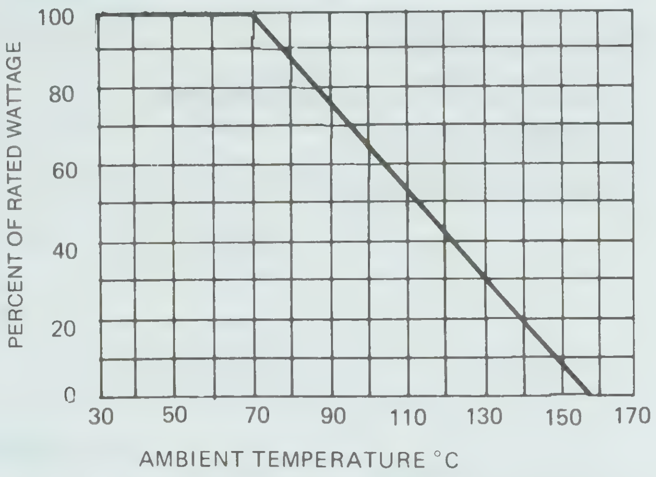


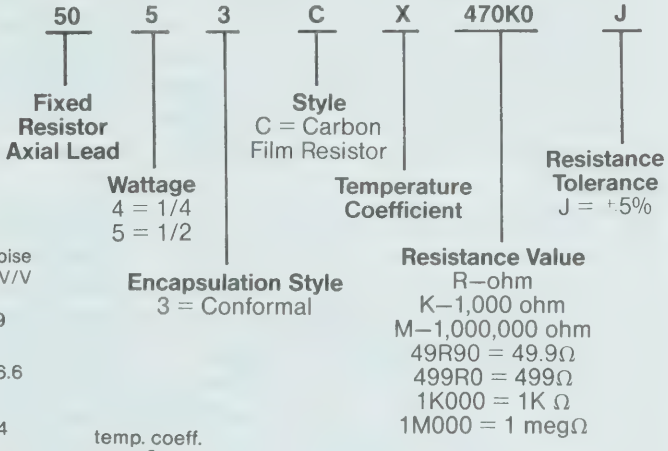
Figure 1. Noise as a function of the resistance value, applicable to all resistor wattages.

DERATING CURVE



HOW TO SPECIFY

CR SERIES Resistors can be completely specified using the following designation:



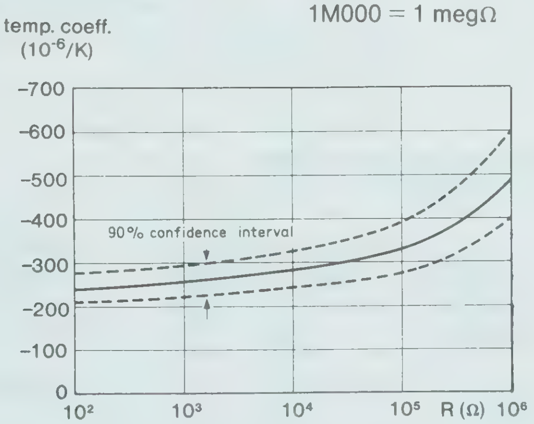
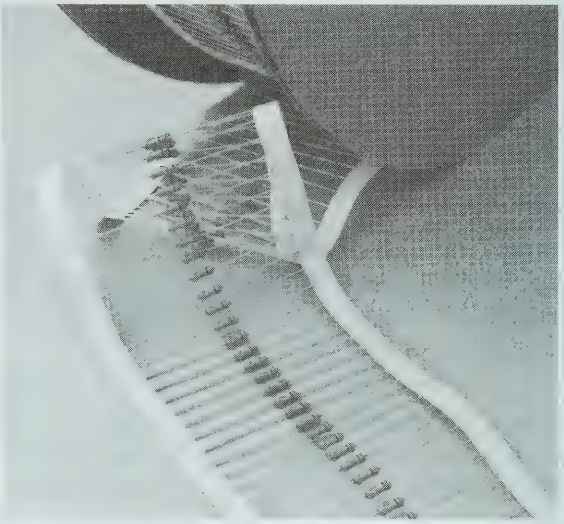


Figure 2. Temperature coefficient as a function of the resistance value, applicable to all resistor wattages. For values <10 Ω & >1Meg the Temperature Coefficient is ≦ +200 x 10^{-6}/ ° C

SFR SERIES 5043E

Standard Film Resistor

METAL FILM
1%, 2%, 5% Tolerances
¼ Watt (70°C)
Power Ratings



DESCRIPTION

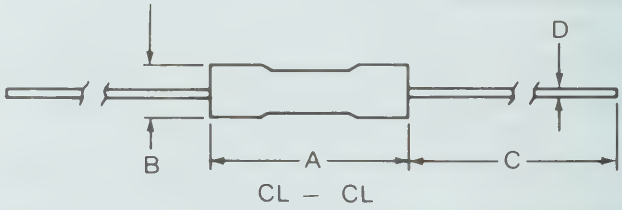
Philips Components now offers a low cost metal film resistor in a 1/4 watt with a wide range of resistance values and tolerances. Designed for high value manufacturing and automatic insertion, the SFR series provides an economic way to upgrade your circuit with the superior stability, temperature coefficient, low noise and low reactance inherent in a well designed metal film resistor.

The ±2% and ±5% tolerance SFR's have a temperature coefficient of ±200 PPM/°C and are specifically designed for replacement of carbon composition (RCR 07 & 20), carbon film and older design metal film resistors such as RL07 and RL20. The ±1% SFR55D's with their ±100 PPM/°C temperature coefficient are specifically designed for high volume 1/4 watt resistor applications requiring RN55D performance.

FEATURES

- Better than Military Performance (MIL-R-10509, RN55)
- Compact Construction for Down to .350 in. Centers (.260 In. Max. Clean Lead to Clean Lead)
- Color Band Marking for Ease of Identification after Mounting
- Tape and Reel Package for Automatic Insertion

Designed To Put The Maximum Performance Into The Circuit At The Lowest Possible Cost.



SPECIFICATIONS

SFR Style	Resistance Range	Resistance Tolerance	Temperature Coefficient	70°C Power Rating	Maximum Voltage	A Max	B Max	C Max	D Nom
5043EM (SFR 25)	10Ω - 1MΩ 1Ω - 10MΩ	±2% ±5%	±200 PPM/°C	¼ watt	250 VRMS	.260 in. 6.6 mm	.098 in. 2.49 mm	1.1 in. 27.9 mm	.024 in. .6 mm
5043ED (SFR 55)	10Ω - 1MΩ	±1%	±100 PPM/°C	¼ watt	250 VRMS	.260 in. 6.6 mm	.098 in. 2.49 mm	1.1 in. 27.9 mm	.024 in. .6 mm

Lead Material: Oxygen free copper 30/70 Tin/Lead Plated Type C (Mil-Std 1276)
Coating: Modified epoxy phenol
Zero-ohm jumpers available upon request

SFR SERIES
Standard Film Resistor

LECTRICAL CHARACTERISTICS COMPARISON

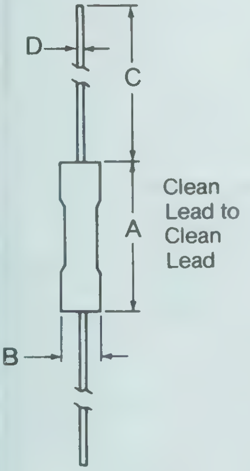
Specification	Size	SFR Series	Mil-R-39008 RCR	Mil-R-22684 RL	Mil-R-10509 Char. D, RN
Resistance Range	¼ watt	1Ω - 10MΩ	2.7Ω - 22MΩ	51Ω - 150KΩ	10Ω - 301KΩ
Tolerance	¼ watt	±1%, ±2%, ±5%	±5%, ±10%	±2%, ±5%	±1%
Temperature Coefficient PPM/°C	¼ watt	±100, ±200	±5000	±200	±100
Maximum Operating Voltage (DC or RMS)	¼ watt	250	250	250	250
Operating Temperature Range		−55°C to +155°C	−55°C to 150°C	−55°C to 150°C	−55°C +165°C

ERFORMANCE SPECIFICATIONS COMPARISON

Test	Maximum % Change in Resistance (△R)			
	SFR Series Average	Mil-R-39008 Style RCR Requirement	Mil-R-22684 Style RL Requirement	Mil-R-10509 Style RN Requirement
Temperature Cycling, −65°C to +150°C	0.1%	4.0%	1.0%	0.5%
Low Temperature Operation, −65°C	0.1%	3.0%	0.5%	0.5%
Short Time Overload	0.1%	2.5%	0.5%	0.5%
Terminal Strength, 5 lb. pull	0.01%	1.0%	0.5%	0.2%
Resistance to Soldering Heat, +350°C	0.05%	3.0%	0.5%	0.5%
Moisture Resistance, Mil Std 202	0.1%	15.0%	1.5%	1.5%
Life 1000 hrs	0.25%	10.0%	2.0%	1.0%
Shock, 50G, 11 ms	0.05%	—	0.5%	0.5%
Vibration-High Frequency, 10-2000Hz	0.05%	2.0%	0.5%	0.5%

HYSICAL COMPARISON

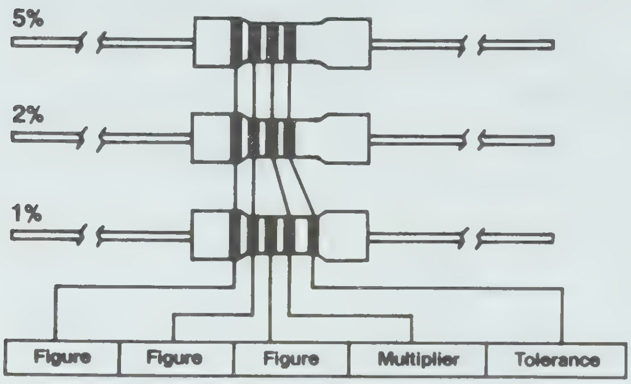
UTLINE DRAWING



Style	Dimensions			
	A	B	C	D
5043E	.260 max	.098 max	1.1 min	.024 ± .002
RCR07	.250 ± .031	.090 ± .008	1.5 ± .125	.023 to .027
RL07	.243 ± .038	.090 ± .008	1.5 ± .125	.019 to .027
RN55D	.250 + .031 −.046	.109 ± .031	1.5 ± .125	.023 to .027

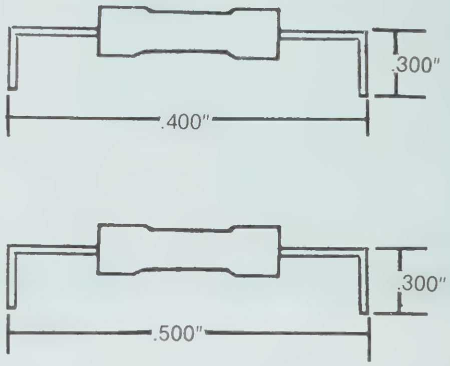
SFR SERIES
Standard Film Resistor

PART MARKINGS



Color	Figure	Multiplier	Tolerance
Black	0	1	—
Brown	1	10	1%
Red	2	100	2%
Orange	3	1K	—
Yellow	4	10K	—
Green	5	100K	—
Blue	6	1M	—
Violet	7	—	—
Gray	8	—	—
White	9	—	—
Gold	—	.1	5%

CUT AND FORM



HOW TO SPECIFY

SFR Series Resistors can be completely specified using the following designation:

50 4 3 E M 470K0 G

50 — Fixed Resistor Axial Lead

4 — Power Rating
4 = ¼ W–SFR 25, SFR55D

3 — Encapsulation Style
3 = Conformal

E — Style
E = Standard Film Resistor

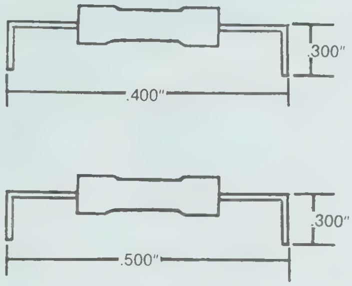
M — Temperature Coefficient
D = ±100 PPM/°C (SFR 55D)
M = ±200 PPM/°C

470K0 — Resistance Value
R–ohm
K–1,000 ohm
M–1,000,000 ohm
49R90 = 49.9Ω
499R0 = 499Ω
1K000 = 1KΩ
1M000 = 1 megΩ

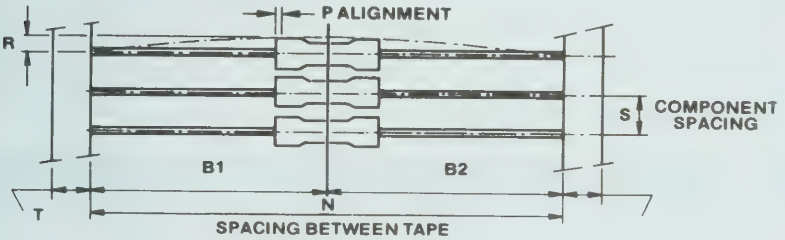
G — Resistance Tolerance
F = ±1% (SFR55D)
G = ±2%
J = ±5%

TAPED LEAD & REEL PACKAGE CONFIGURATIONS, CUT AND FORM

All Philips Components SFR Fixed Film resistors are furnished in taped-lead format, in multiples of 5000 pieces, to suit the requirements of automated production. Bulk available upon request.

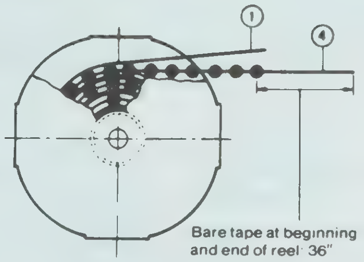


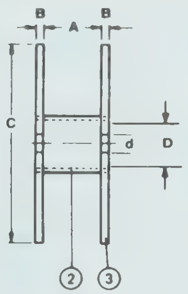
LEAD TAPING DIMENSIONS



Dimension in Inches (millimeters in bold type)—see diagram.						
P/N	B1-B2 (± max.)	N	P (max.)	R (max.)	S	T
5043E	0.047 **1.2**	2.062 ± .062 **52.4 ± 1.6**	0.031 **0.8**	0.039 **1**	0.200 **5**	0.250

EL PACKAGING MENSIONS





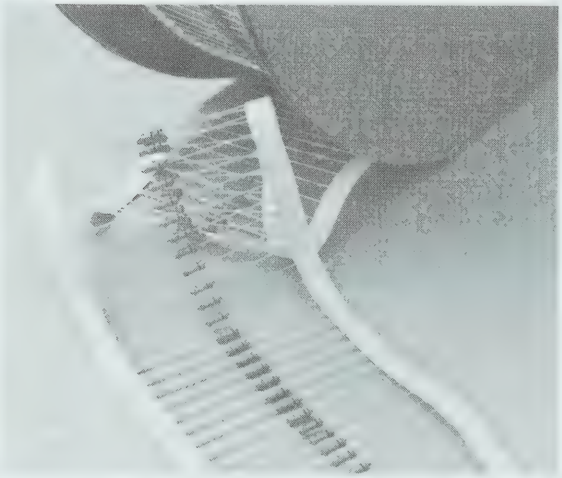
1. Kraft paper (brown)
2. Spirally-wound paper spool
3. Cardboard disc
4. Scotch No. 267, or comparable tape/tape system

Dimension in Inches (millimeters in bold type)—see diagram.						
P/N	A (max.)	B	C	D	d	Quantity Per Reel
5043E	2.95 **75**	0.118 **3**	12.0 **305**	3.03 **77**	1.18 **30**	5,000

5053H (SFR25H)

Metal Film Resistor

1%, 5% Tolerances ½ Watt at 70°C Power Rating Miniature Size



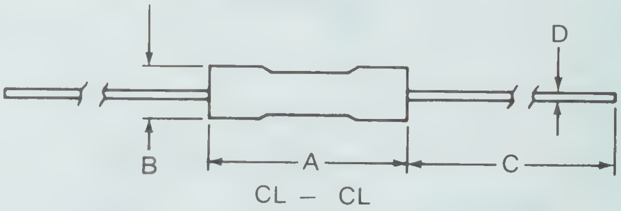
Designed to put the maximum performance into the circuit in the minimum space.

DESCRIPTION

Philips Components has combined the low cost manufacturing of the SFR series with a high conductivity, high density alumina substrate resulting in a low cost, superior performance, ½ watt resistor with about 50% of the footprint of a conventional ½ watt resistor. The 5053H retains all the advantages of the SFR series: Uniform size, low reactance, low noise, excellent temperature coefficient of resistance and stability. The 5053H complements the SFR60D and SFR30 in the Philips Components line. It is a replacement for the RC20, RN60, and RL20 Mil styles in applications not requiring qualification.

FEATURES

- Miniature Size for Minimum Board Space Requirements (Can be placed on .350 in. centers)
- Color Band Marking for Ease of Identification after mounting.
- Tape & Reel Packaging for Automatic Insertion.
- Better than Mil Performance (MIL-R-10509, MIL-R-22684)



SPECIFICATIONS

Philips Components P/N (Type)	Resistance Range*	Resistance Tolerance	Temperature Coefficient	70°C Power Rating	Maximum Voltage	A Max	B Max	C Nom	D Nom
5053H (SFR25H)	10Ω - 1MΩ 1Ω - 10MΩ	±1% ±5%	±100 PPM/°C ±200 PPM/°C	½ watt	350 VRMS	.260 in. 6.6 mm	.098 in. 2.49 mm	1.1 in. 28.0 mm	.024 in. .6 mm

*Within the resistance ranges shown, the available resistance values are indicated in the MIL 10 to 100 decade table of values and their decade multiples.

SERIES 5053H

Metal Film Resistor

ELECTRICAL CHARACTERISTICS COMPARISON

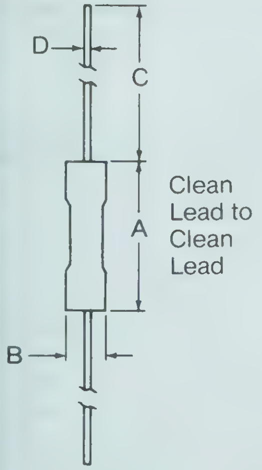
Specification	5053H (½ Watt)		MIL-R-39008 RCR (1/2 Watt)	MIL-R-22684 RL (1/2 Watt)	MIL-R-10509 Char. D, RN (1/2 Watt)
	1%	5%			
Resistance Range	10Ω - 1MΩ	1Ω - 10MΩ	2.7Ω - 22MΩ	51Ω - 150KΩ	10Ω - 301KΩ
Tolerance	±1%	±5%	±5%, ±10%	±2%, ±5%	±1%
Temperature Coefficient PPM/°C	±100	±200	±5000	±200	±100
Maximum Operating Voltage (DC or RMS)	350	350	350	350	350
Operating Temperature Range	−55°C to +155°C		−55°C to +150°C	−55°C to +150°C	−55°C to +165°C

PERFORMANCE SPECIFICATIONS COMPARISON

Test	Maximum % Change In Resistance (△R)			
	5053H	MIL-R-39008 Style RCR Requirement	MIL-R-22684 Style RL Requirement	MIL-R-10509 Style RN Requirement
Temperature Cycling, −65°C to +150°C	≤ .25%	4.0%	1.0%	0.5%
Low Temperature Operation, −65°C	≤ .25%	3.0%	0.5%	0.5%
Short Time Overload	≤ .25%	2.5%	0.5%	0.5%
Terminal Strength, 5 lb. pull	≤ .25%	1.0%	0.5%	0.2%
Resistance to Soldering Heat, +350°C	≤ .25%	3.0%	0.5%	0.5%
Moisture Resistance, Mil-Std-202	≤ .5%	15.0%	1.5%	1.5%
Life, 1000 hrs	≤ 1.0%	10.0%	2.0%	1.0%
Shock, 50G, 11ms	≤ .25%	—	0.5%	0.5%
Vibration-High Frequency, 10-2000 Hz	≤ .25%	2.0%	0.5%	0.5%

PHYSICAL COMPARISON

OUTLINE DRAWING



Style	Dimension (in.)			
	A	B	C	D
5053H	.260 max	.098 max	1.1 nom	.024 ± .002
RC20	.375 ± .031	.138 ± .023	1.5 ± .125	.026 to .036
RL20	.380 ± .036	.138 ± .023	1.5 ± .125	.026 to .036
RN60D	.375 ± .062	.125 ± .40	1.5 ± .125	.025 ± .002

6

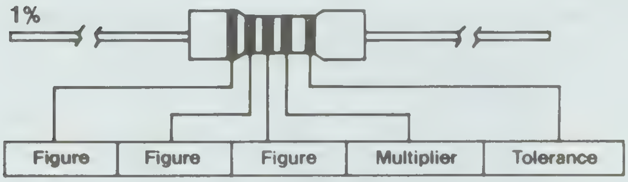
Fixed Resistors

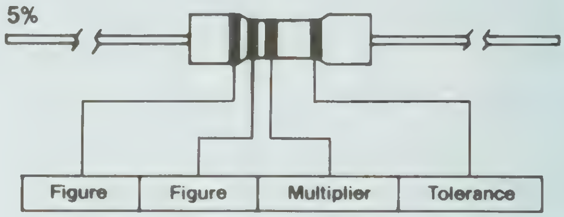
SERIES 5053H

Metal Film Resistor

PART MARKINGS

5053H (1%, 5%)





Color	Figure	Multiplier	Tolerance
Black	0	1	—
Brown	1	10	1%
Red	2	100	—
Orange	3	1K	—
Yellow	4	10K	—
Green	5	100K	—
Blue	6	1M	—
Violet	7	—	—
Gray	8	—	—
White	9	—	—
Gold	—	.1	5%

HOW TO SPECIFY

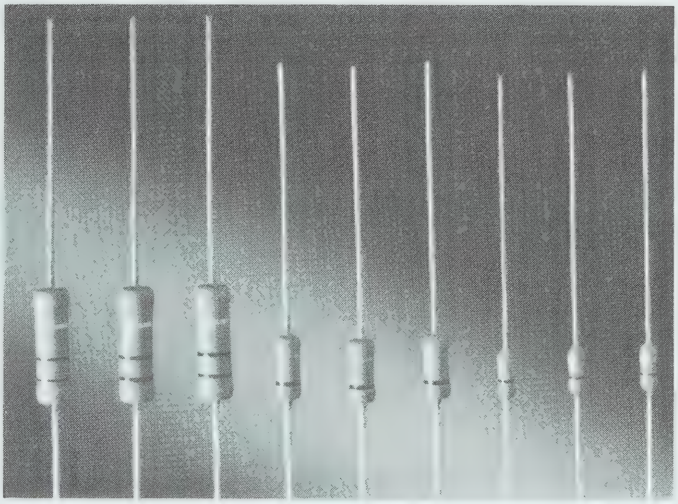
5053H Series Resistors can be completely specified using the following designation:

50 5 3 H D 470K0 F

- **50** — **Fixed Resistor Axial Lead**
- **5** — **Power Rating**: 5 = ½ W
- **3** — **Encapsulation Style**: 3 = Conformal
- **H** — **Style**: H = Standard Film Resistor Miniature ½ W
- **D** — **Temperature Coefficient**: D = ±100 PPM/°C; M = ±200 PPM/°C
- **470K0** — **Resistance Value**: R = ohm; K = 1,000 ohm; M = 1,000,000 ohm; 49R9 = 49.9; 499R0 = 499; 1K000 = 1K; 1M000 = 1 Meg
- **F** — **Resistance Tolerance**: F = ±1%; J = ±5%

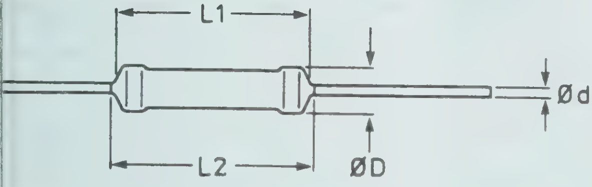
PR SERIES
Miniature Power Film Resistor, Metal Film

5% Tolerance
1, 2, and 3 Watt @ 70°C



DESCRIPTION
he PR Series Metal Film Power Resistor Line ffers the designer a low cost alternative to conentional power film resistors in a convenient mall body size. The use of a high conductivity, igh density substrate allows the performance f the PR series to equal that of the larger conentional power film resistors.

DIMENSIONS



EATURES
- Small Size for Minimum Board Space
- Low Inductance
- Color Band Marking for Ease of Identification
- Flameproof Coating which withstands all solvents per MIL-STD-202, Method 215
- Wide Resistance Range 1 ohm to 1 Megohm

PERFORMANCE SPECIFICATIONS

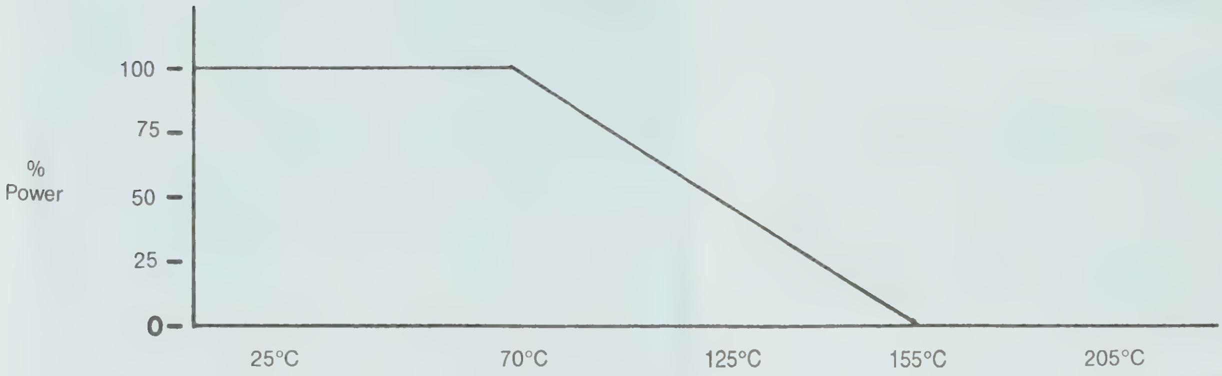
	Max. % Delta R
Thermal Shock	1%
Terminal Strength	.5%
Humidity (Mil-Std-202, Method 103, Condition D, .01 X Rated Power)	3%
Life (1000 HR @ Rated Power)	5%
Vibration	.5%
Effect of Solder	1%
Shock	.5%

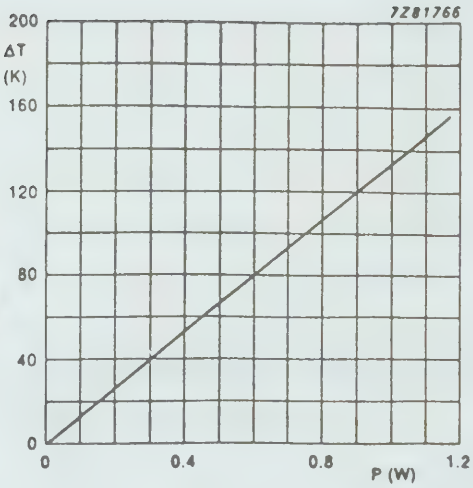
PECIFICATIONS

Style	Resistance Range (ohms)	Resistance Tolerance (%)	Temperature Coefficient (PPM/°C)	70°C Power Rating	Max Voltage (Volts)	Dimensions A Max	B Max	C Max	D Max	E Max
PR01 5073NW	1R ≥ 1M	±5%	±250	1 Watt	350	.098" 2.5mm	.256" 6.5mm	.315" 8.0mm	1.5" 38.1mm	.024" .6mm
PR02 5083NW	1R ≥ 1M	±5%	±250	2 Watt	500	.154" 3.9mm	.394" 10mm	.433" 11mm	1.5" 38.1mm	.031" .8mm
PR03 5093NW	1R ≥ 1M	±5%	±250	3 Watt	750	.205" 5.2mm	.657" 16.7mm	.705" 17.9mm	1.5" 38.1mm	.031" .8mm

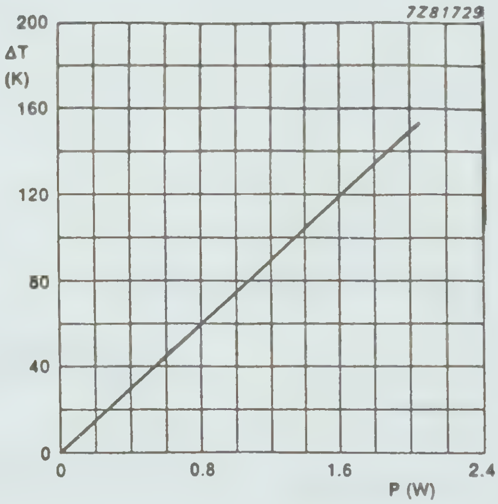
PR SERIES
Miniature Power Film Resistor, Metal Film

Derating Curve

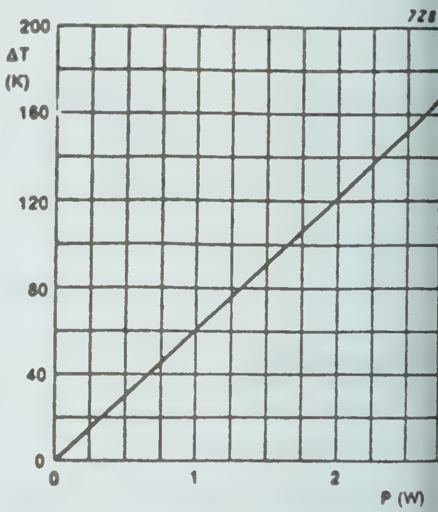




PR01



PR02



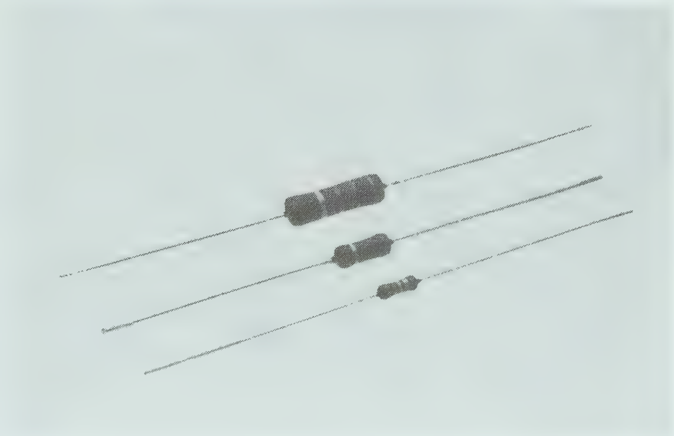
PR03

PACKAGING

type	tape width	packaging	quantity	resistance range	tolerance
PR01	52mm	reel	5000	1 Ω to 1M Ω	± 5%
PR02	52mm	reel	5000	1 Ω to 1M Ω	± 5%
PR03	72mm	ammo pack	1000	1 Ω to 1M Ω	± 5%

High Voltage Resistor

5% Tolerance 1/4, 1/2, and 1 Watt (70°C) Power Rating High-Ohmic/High-Voltage



DESCRIPTION

A cermet film is deposited on a high grade ceramic body. After a helical groove has been cut in the resistance layer, solder plated electrolytic copper lead wire is welded to the end caps. The resistors are coated with a blue insulating lacquer, which also provides protection against environmental effects.

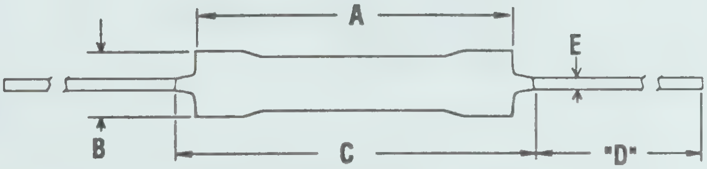
APPLICATION

VR Series resistors are used in circuitry where high resistance, stability and reliability are required in the presence of high voltages.

FEATURES

- Resistance Values to 220 Megohm
- Voltages up to 10 Kilovolt
- Color Band Marking

DIMENSIONS



SPECIFICATIONS

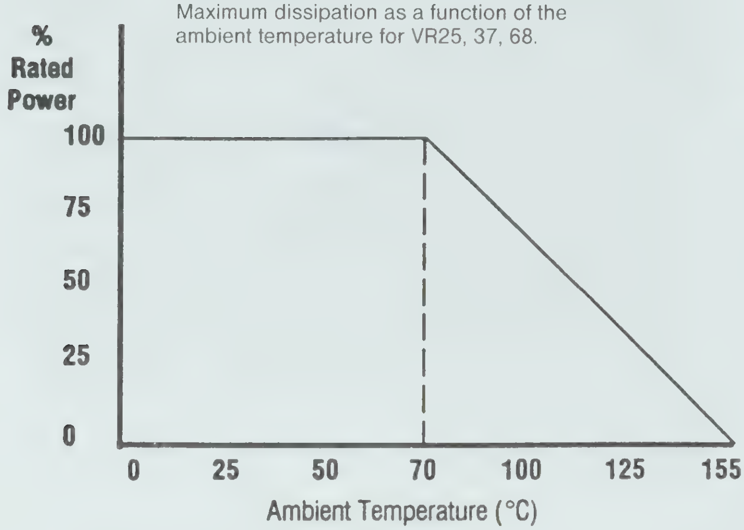
Style	Value Range (Ohms)	Power Rating 70°C (Watts)	Resistance Tolerance (%)	TC of R (PPM/°C)	Limiting Voltage		Dimensions					Packaging
					dc	rms	A Max	B Max	C Max	D Nom	E Max	
VR25 5043DM	100K to 22 Meg	1/4	±5%	±200	1600V	1150V	.256″	.098″	.295″	1.1″	.024″	Tape & Reel 5000 PC
VR37 5053DM	100K to 39 Meg	1/2	±5%	±200	3500V	2500V	.354″	.146″	.394″	1.1″	.028″	Tape & Reel 5000 PC
VR68 5073DM	100K to 220 Meg	1	±5%	±200	10000V	7000V	.650″	.268″	.748″	1.1″	.032″	Ammo Pak 500 PC

VR SERIES

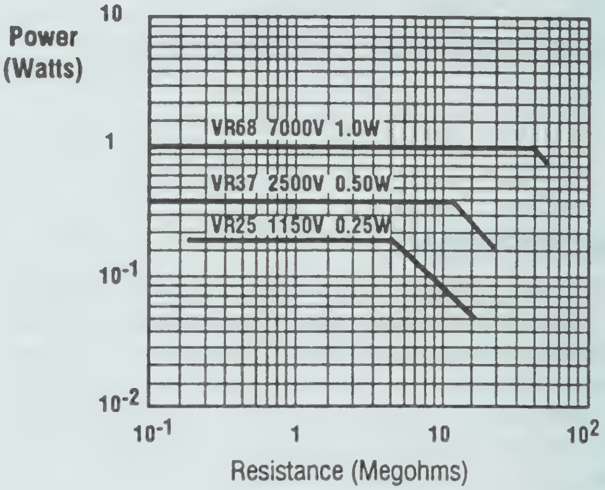
High Voltage Resistor

DERATING CURVE

Maximum dissipation as a function of the ambient temperature for VR25, 37, 68.



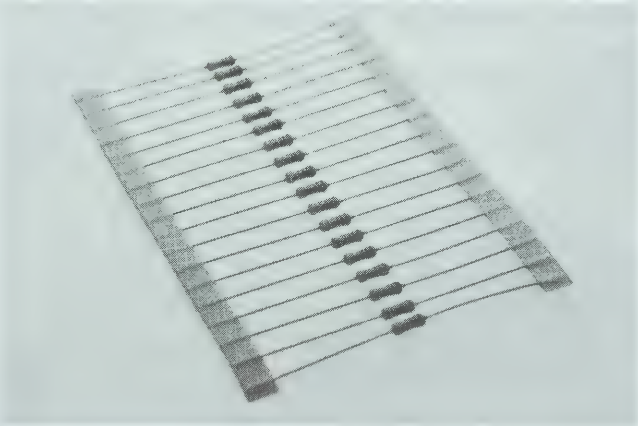
Power vs. Resistance Value of High-Voltage Resistors at $T_{amb} = 70°C$.



PERFORMANCE CHARACTERISTICS

	VR25	VR37	VR68
Thermal Shock (Max %△R)	0.5%	0.5%	0.5%
Moisture (Max %△R)	3%	1.5%	1.5%
Life 1000 hr @ Rated Power (Max %△R)	3%	1.5%	1.5%
Vibration	0.5%	0.5%	0.5%
Effect of Solder (Max %△R)	0.5%	0.5%	0.5%
Noise (Max.)	$5^{\mu V}/_V$	$2.5^{\mu V}/_V$	$2.5^{\mu V}/_V$
Dielectric Strength (rms) Min.	700V	700V	700V

NFR SERIES
Fusible Metal Film Resistor



5% Tolerance
1/4, 1/3, and 1/2 Watt
(70°C) Power Rating

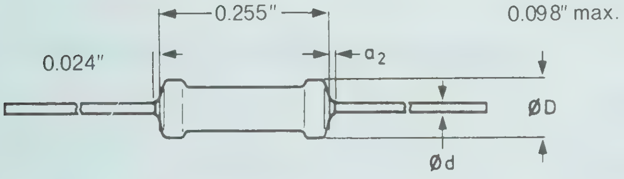
DESCRIPTION

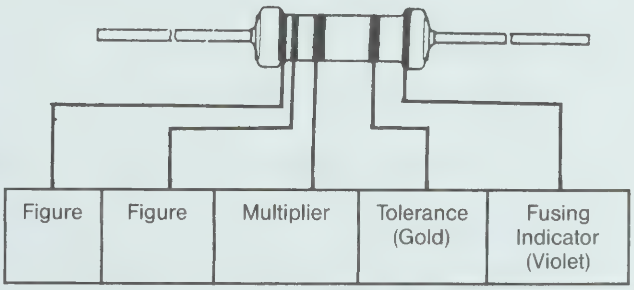
NFR Series Fusible Resistors are designed to meet the safety requirements in electronic applications where protection against overloads is required. Within the specified overload range the resistor will become an open circuit without the risk of fire. The circuit opens, in general, within 30 seconds at 4 watts and 10 seconds at 6 watts for NFR25; and within 30 seconds at 9 watts and 10 seconds at 12 watts for NFR25H. See Figures 1, 2, and 3 for time to interruption as a function of overload. "Interruption" is defined as the resistance having increased at least 10 times for NFR25 and at least 100 times for NFR25H resistors.

FEATURES

- Fusing Characteristic
- Small Quarter-Watt Body Size
- Solvent Resistant
- Flame Retardant Coating
- Tape and Reel (5,000 Pieces)
- Thick violet color band—indicates fusible
- Color Band Marking
- Final violet color band—indicates fusible

DIMENSIONS





SPECIFICATIONS

Philips Components Style	Resistance Range (Ohms)	Resistance Tolerance (%)	Temperature Coefficient (PPM/°C)	70°C Power Rating (Watts)	Maximum Continuous Working Voltage (rms)
NFR25 5063F	1 < 15R 15R ≤ 15K	±5% ±5%	200 100	1/4, 1/3 1/4, 1/3	250 250
NFR25H 5053F	1R ≤ 4.99R 5R ≤ 15K	±5% ±5%	200 100	1/2 1/2	350 350

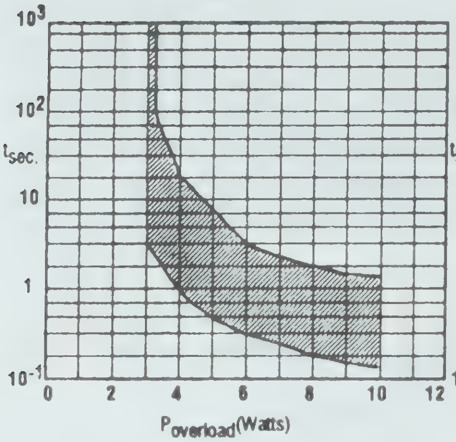
NFR SERIES

Fusible Metal Film Resistor

PERFORMANCE CHARACTERISTICS

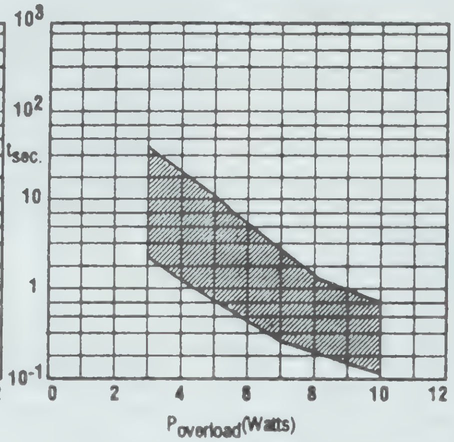
Time to Interruption as a function of overload.

FIGURE 1.



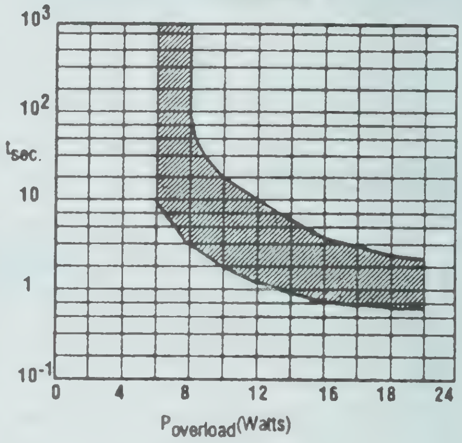
NFR25; R ≤ 15 OHMS

FIGURE 2.



NFR25; 15 OHM < R ≤ 15 kOHMS

FIGURE 3.

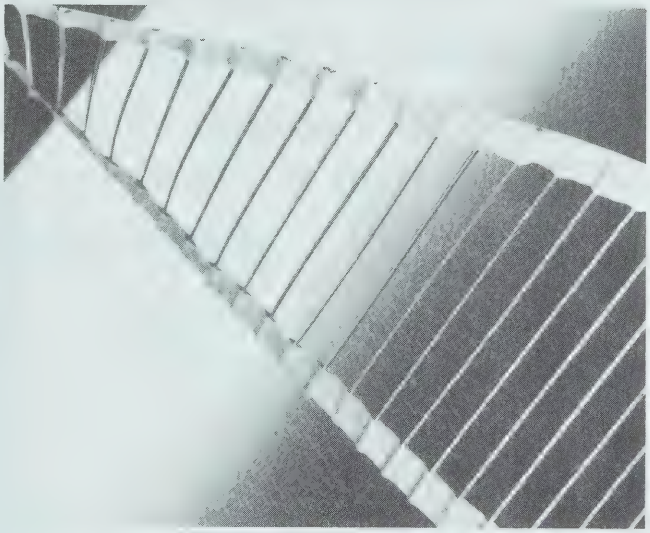


NFR25H; 1 ≤ R ≤ 15 kOHMS

Since these resistors are used in applications where overloads can occur, it is not recommended to mount them against other components or in direct contact with printed circuit boards.

	NFR 25	NFR25H
Effect of Solder	0.25%ΔR	0.25%ΔR
Load Stability (1000 hrs)	1.0%ΔR	0.25%ΔR
Insulation Resistance	10^4Mohm Min	10^4Mohm Min
Noise	$< 0.1\ \mu$V/V	$< 0.1\ \mu$V/V
Thermal Shock	0.25%ΔR	0.25%ΔR
Humidity	1.0%ΔR	1.0%ΔR
Dielectric Strength	350V rms	350V rms

Zero Ohm Jumper Wire



DESCRIPTION

- 20 Awg or 22 Awg Diameter Wire
- 30/70 or 40/60 Tin/Lead Plated Wire

FEATURES

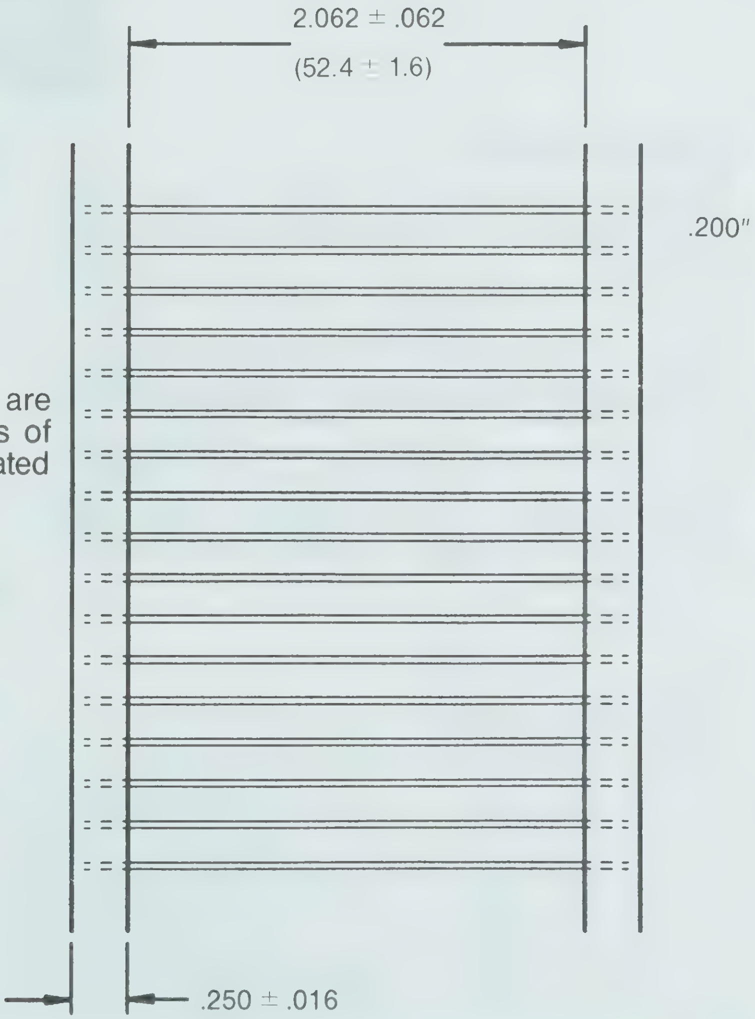
- Compact Construction for .200″ or greater centers
- Resistance = .005 ohms maximum
- Tape and Reel Package for Automatic Insertion
- Designed to Put the Maximum Performance into the Circuit at the Lowest Possible Cost
- Meets EIA Spec RS296D Class I Tape and Reel

PART NUMBER DESCRIPTION

- 20 gauge (.032″) wire jumpers
  5000CXOR000S12AAZ
- 22 gauge (.025″) wire jumpers
  5020CXOR000S12AAZ

PACKAGE CONFIGURATION

All Philips Components SFR Jumper Wires are furnished in taped lead format in multiples of 10,000 pcs to suit the requirements of automated production.

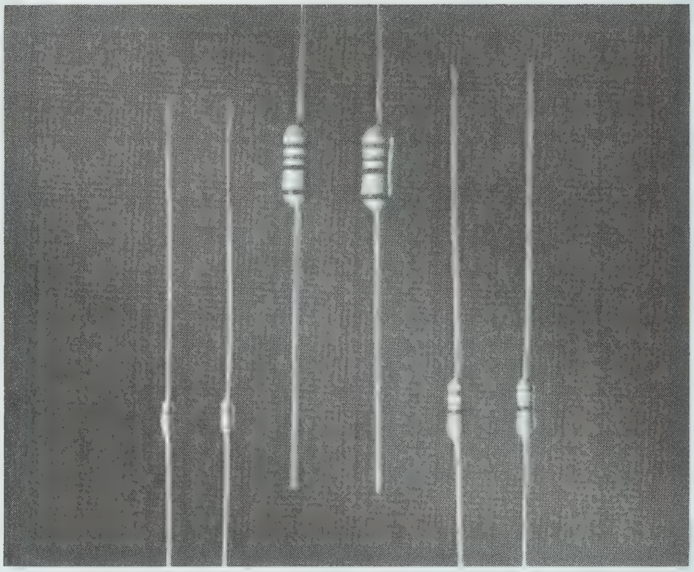


SPR 5000Y SERIES

Standard Precision Film Resistor Resistance Range

1 ohm—250 megohm, .5 to 5% Tolerance

5033Y 1/10 Watt @ 125°C
1/3 Watt @ 70°C
5053Y 1/4 Watt @ 125°C
1/2 Watt @ 70°C
5073Y 1/2 Watt @ 125°C
1 Watt @ 70°C



6

Fixed Resistors

DESCRIPTION

Philips Components offers a film resistor series more compact and with greater power handling capacity. For example, the 5033Y is a mil spec 1/10 watt size yet handles up to 1/3 watt (70°C rating). This combination allows reduction of inventory by a selection of the most convenient 5000Y values to reduce the number of wattage ratings carried. The size/power handling characteristic is also a distinct advantage in "down sized" boards. The 5000Y series is available in standard values between resistance range limits noted below. Operating temperatures up to 150°C are permissible.

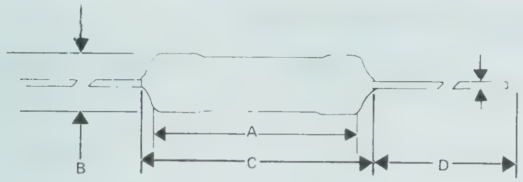
DESIGN FEATURES

- Wide Resistance Range: 1 ohm to 250 megohm.
- Excellent Temperature and Time Stabilities, approaching those of wirewound resistors.
- Low Voltage and Power Coefficients, approaching those of wirewound resistors of comparable size.
- Low Noise. Johnson noise is lowest attainable, except in best wirewound designs.
- High initial accuracy and tracking. Tolerance of 1% is standard.
- Very Low Reactance—low series L, low shunt C; reactance error is generally less than tolerance up to 10MHz, for most resistance values.

SPR 5000Y SERIES

Standard Precision Film Resistor

DIMENSIONS

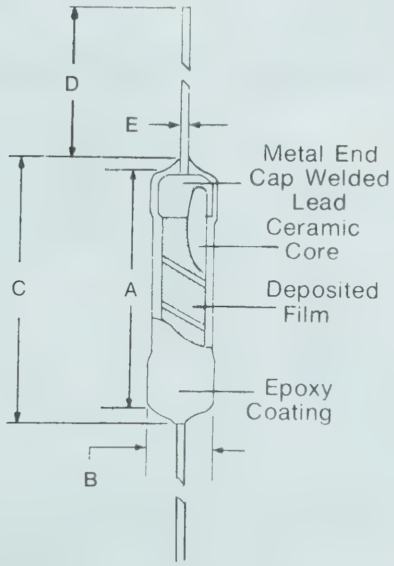


SPECIFICATIONS & NOMENCLATURE–5000Y SERIES

Philips Components Style	Maximum Power Rating	Resistance Range* (ohms)	Temperature Coefficient (PPM/°C)	Resistance Tolerance	Max. Voltage (volts)	Dimensions—see diagram Inches (mm)				
						A	B	C**	D	E
5033Y	1/10 W@ 125°C 1/3 W@ 70°C	1 Ω to 12 M	±50 PPM 10Ω-750K ±100 PPM 1Ω-2M ±150 PPM 1M-24M9	±0.5% (10Ω499K) ±1.0% ±2.0% ±5.0%	250	.150 ±.020 (3.81) ±0.51	.070 ±.010 (1.79) (±0.23)	.200 Max. (5.08)	1.5 (38.1)	.020 (.51) #24
5053Y	1/4 W@ 125°C 1/2 W@ 70°C	1 Ω to 250 M	±50 PPM 10Ω-2 M ±100 PPM 1Ω-10 M ±150 PPM 2 M-250 M	±0.5% (10Ω-2 M) ±1.0% ±2.0% ±5.0%	350	.261 ±.020 (6.63 ±0.51)	.093 ±.005 (2.362 ±0.13)	.300 Max. (7.62)	1.5 (38.1)	.025 (.63) #22
5073Y	1/2 W@ 125°C 1 W@ 70°C	1 Ω to 25 M	±50 PPM 10Ω-3M01 ±100 PPM 1Ω-4M99	±0.5% (10Ω-4 M) ±1.0% ±2.0% ±5.0%	500	.390 ±.020 (9.91 ±0.51)	.152 ±.009 (3.861 ±0.23)	.430 Max. (10.92)	1.5 (38.1)	.025*** (.63) #22

*Within the resistance ranges shown, values indicated in the decade table of values, and their decade multiples, are available as standard. Other values are available on special order.

Clean-lead to clean-lead. *.032" leads available on request.



PERFORMANCE CHARACTERISTICS

As a guide to the performance that can be expected of SPR5000Y resistors, the following chart indicates typical results of tests performed in accordance with MIL-R-10509.

Test	Max. % Change in Resistance: MIL-R-10509 (Characteristics C & E) Requirements	SPR 5000Y Average
Temperature Cycling, −65° to +150°C	.25%	.05%
Low temperature operation, −65°C	.25%	.02%
Short time overload	.25%	.02%
Terminal strength, 5 lb. load	.20%	.02%
Dielectric Withstanding Voltage	.25%	.01%
Resistance to soldering heat, 350°C	.10%	.01%
Moisture resistance	.50%	.05%
Life (1,000 hours)	.50%	.25%
Shock, medium impact, 50G, 11 ms.	.25%	.01%
Vibration, High frequency 10-2000 Hz	.25%	.01%

6

Fixed Resistors

SPR 5000Y SERIES

Standard Precision Film Resistor

COMPARISON SPECIFICATIONS			
STYLE	PHILIPS COMPONENTS SPR5000Y	MIL-R-22684	MIL-R-10509
Maximum Operating Temperature	150°C 125°C	+150°C	+165°C
1000 Hour Load Life △ R	<1.0%	<1.0%	<1.0%
Moisture Resistance △ R	<0.5%	<1.5%	<1.5%
Short Time Overload △ R	<0.1%	<0.5%	<0.5%

MARKING

Resistors are marked using color bands or alpha-numeric marking as specified by customer.

PACKAGING

Bulk (100 pieces per box) or Lead Tape and Reel per EIA RS-296D.

LEAD MATERIAL

Type C, MIL-STD-1276 (tin-lead plating over Oxygen-free high conductivity Copper)

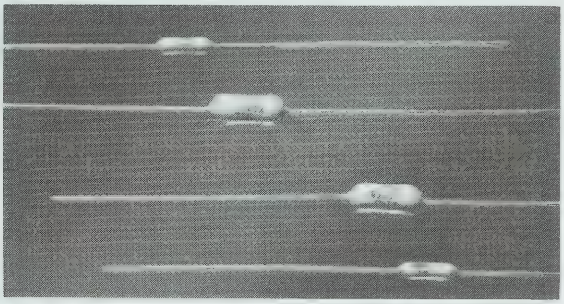
HOW TO SPECIFY

SPR 5000Y Resistors can be completely specified using the following designation:

50	5	3	Y	D	1K000	P
Fixed Resistor Axial Lead	**Wattage** 3 = 1/3 5 = 1/2 7 = 1	**Encapsulation** 3 = Conformal	**Style**	**Temperature Coefficient** C = ±50 D = ±100 L = ±150PPM	**Resistance Value** R–ohm K–1,000 ohm M–1,000,000 ohms 49R90 = 49.9Ω 499R0 = 499Ω 1K000 = 1KΩ 1M000 = 1 megΩ	**Resistance Tolerance** D = ±0.5% F = ±1.0% G = ±2.0% J = ±5.0%

UPR 5000Z SERIES

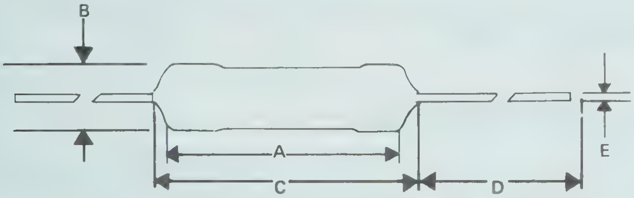
Ultra Precision Resistor Tolerance To ±0.01% Temperature Coefficients To ±2 PPM/°C



DESCRIPTION

Philips Components offers a film resistor designed for use in ultra precision applications previously requiring the finest wirewound resistors available. The 5000Z series of resistors is available with tolerances to .02% and temperature coefficients to ±2 PPM/°C in package sizes much smaller than those of wirewounds. The 5000Z series is particularly well suited for uses in matched sets, with matches to ±.01% and 2 PPM/°C tracking. Proprietary Philips Components processes make the 5000Z one of the most stable film resistors currently available on the market.

DIMENSIONS



DESIGN FEATURES

- Temperature coefficients and tolerances approaching the lowest attainable using film techniques.
- Excellent temperature and time stabilities, approaching those of wirewound resistors.
- Low voltage and power coefficients, approaching those of wirewound resistors of comparable size.
- Low noise. Johnson noise is close to lowest attainable, except in best wirewound designs.
- High initial accuracy and tracking. Tolerance matches of .01% and TC tracks of 2 PPM/°C are available.
- Very low reactance—low series L, low shunt C: reactance error is generally less than tolerance up to 10MHz, for most resistance values.
- Temperature Range: −20°C to +85°C.

SPECIFICATIONS AND NOMENCLATURE—5000Z SERIES

Philips Series	Maximum Power Rating (85°C)	Resistance Range* (ohms)	Temperature Coefficient*** (PPM/°C)	Resistance Tolerance	Max Voltage	Dimensions—See Diagram Inches (mm)				
						A	B	C**	D	E
5013Z	1/20 WATT	51.1Ω to 100K	±2 PPM (100Ω-301K) ±5 PPM ±10 PPM ±15 PPM ±20 PPM ±25 PPM	±.01 % ±.025% ±.05 % ±.10 % ±.25 % ±.50 % ±1.00%	200V	.150±.020 (3.81±0.51)	.070±.010 (1.79±0.23)	200 (5.08)	1.5 (38.1)	0.16 (#26) (.41)
5023Z	1/8 WATT	51.1Ω to 511K			250V	.261±.020 (6.63±0.51)	.093±.005 (2.36±.13)	.300 max (7.26 max.)	1.5 (38.1)	0.25 (#22) (.63)
5033Z	1/4 WATT	51.1Ω to 511K			300V	.396±.020 (10.1±.51)	.152±.009 (3.86±.23)	.430 max (10.9 max.)	1.5 (38.1)	0.25 (#22) (.63)
5063Z	1/3 WATT	51.1Ω to 511K			300V	.390±.020 (9.91±5.1)	.152±.009 (3.86±.23)	.430 max (10.9)	1.5 (38.1)	0.32 (#20) (.81)

*Within the resistance ranges shown, values indicated in the decade table of values and their decade multiples, are available as standard. Other values are available on special order.

**Clean-lead to clean-lead.

***Temperature coefficient is measured over the temperature range of −20°C to +85°C for all TC's except 2 PPM. 2 PPM is measured at 0°C to +60°C.

UPR 5000Z SERIES

Ultra Precision Resistor

PERFORMANCE COMPARISONS TO MIL SPEC TEST GROUPS

	Wirewound Specification MIL-R-93D	Metal Film Specification MIL-R-55182	Philips Components 5000Z Series
Standard Tolerance Range	±.005% to ±1%	±.1% to ±1%	±.02% to ±1%
Test Group II	Specified Max. ΔR	Specified Max. ΔR	Max. ΔR
Temperature Cycling	.20%	.20%	.02%
Low Temperature Operation	.25%	.15%	.01%
Short time Overload	.10%	N/A	.01%
Terminal Strength	.05%	.20%	.02%
Test Group III	Specified Max. ΔR	Specified Max. ΔR	Max. ΔR
Dielectric withstand voltage			
(a) Atmospheric Pressure	.05%	.15%	.01%
(b) Barometric Pressure	.05%	.15%	.01%
Insulation resistances	N/A	>10,000 MegΩ	>10,000 MegΩ
Effect of Soldering	N/A	.10%	.01%
Moisture resistance	.25%	.40%	.04%
Test Group IV	Specified Max. ΔR	Specified Max. ΔR	Max. ΔR
Temperature Coefficient	20PPM/°C to 90PPM/°C	25PPM/°C to 100PPM/°C	2PPM/°C to 25PPM/°C
Life Test	.50% (125°C)	.50% (125°C)	.02% (85°C)
Test Group V	Specified Max. ΔR	Specified Max. ΔR	Max. ΔR
Shock	.10%	.20%	.01%
Vibration, High Frequency	.10%	.20%	.01%
Non Military Tests			
Voltage Coefficient	N/A	N/A	≤.1 PPM/V
Thermal EMF	N/A	N/A	<2 μV/°C

6

Fixed Resistors

MARKING

*Standard marking is Alpha-Numeric
Example:

5023Z
100K
.1% T16

*Special marking is available per customer requirement

PACKAGING

Bulk (100 pieces per box) or Lead Tape and Reel per EIA RS-296D

LEAD MATERIAL

Type C, MIL-STD-1276 (tin-lead plating over Oxygen-free high conductivity Copper)

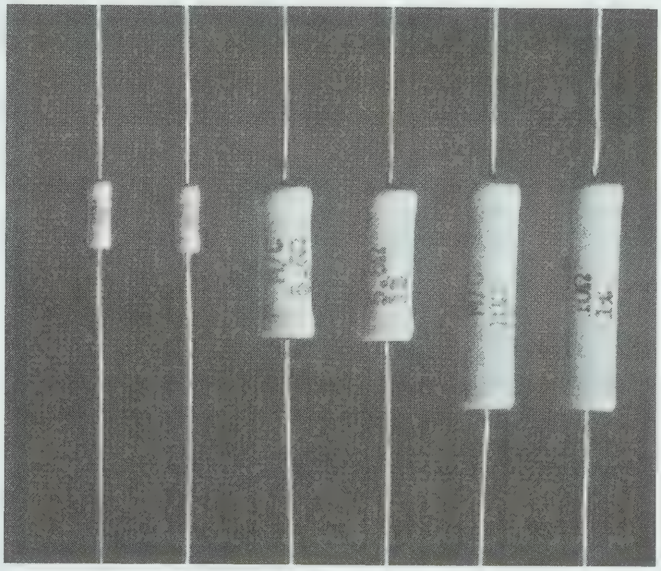
HOW TO SPECIFY

UPR 5000Z Series Resistors can be completely specified using the following designation.

50	2	3	Z	B	1K000	A
Fixed Resistor Axial Lead	Wattage 1 = 1/20 2 = 1/8 3 = 1/4 6 = 1/3	Encapsulation 3 = Conformal	Style	Temperature Coefficient (PPM/°C) T = ±2 PPM (T18) A = ±5 PPM (T16) B = ±10 PPM (T13) F = ±15 PPM (T10) G = ±20 PPM (T14) E = ±25 PPM (T9)	Resistance Value R—ohm K—1,000 ohm M—1,000,000 ohm 49R90 = 49.9Ω 499R0 = 499Ω 1K000 = 1KΩ	Tolerance T = ± .01% H = ±0.02% Z = ±0.025% A = ±0.05% B = ±0.10% C = ±0.25% D = ±0.5% F = ±1.00%

PPR5000
Precision Power Film Resistor Metal Film

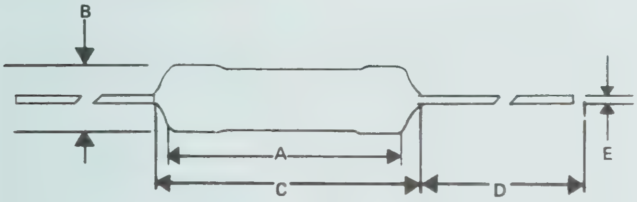
.05% to 1% Tolerances
1, 2, 3 and 5 Watt
(25°C) Power Rating



DESCRIPTION

The PPR5000 series is a precision power film that achieves the inherently low inductance and reliability of metal film resistors and the stability and power handling capability of wirewound resistors.

DIMENSIONS



FEATURES

- Low Inductance
- Excellent Stability
- Small Size
- Tight Tolerances
- Low TC's

Series	Max Power Rating (25°C)	Resistance Range (ohms)	Temperature Coefficient (PPM/°C)	Resistance Tolerance (%)	Max Voltage	A Max In. (mm)	B Max In. (mm)	C Nom In. (mm)	D Nom In. (mm)
5073P	1 watt	5R to 25K	± 20(1)	±.05(2)	160 Volts	.265″ 6.73	.098″ 2.49	1.5″ 38.1	.025″ .06
5083P	2 watts	5R to 25K	± 25	± .1 ±.25	225 Volts	.365″ 9.27	.150″ 3.81	1.5″ 38.1	.025″ .06
5093P	3 watts	5R to 25K	±50 ±100	± .5	275 Volts	.550″ 14.0	.225″ 5.72	1.5″ 38.1	.032″ .08
50A3P	5 Watts	5R to 100K		± 1	500 Volts	.800″ 20.3	.225″ 5.72	1.5″ 38.1	.032″ .08

Values below 10 ohms will have a TC of ± 50 PPM.
.05% and .1% are available 100 ohms and higher only. Also available in 2% and 5% over the entire range.

PPR5000

Precision Power Film Resistor

PERFORMANCE SPECIFICATIONS

	Max. % Delta R
Thermal Shock	.2%
Terminal Strength	.1%
Dielectric Withstanding Voltage	
Atmospheric	.1%
Barometric	.1%
S.T.O.L.	.2%
Moisture Resistance (Load)	.5%
Life (1000 hr @ rated power)	.5%
Vibration	.1%
Effect of Solder	.1%
Shock	.1%

MARKING

*Standard Marking is Alpha/Numeric

Example: .1%
T9

*Special Marking is available per customer requirements.

PACKAGING

Bulk (100 pieces per box for 5073P and 5083P, 50 pieces per box for 5093P and 50A3P)

Tape & Reel per EIA-STD-RS296D.

LEAD MATERIAL

Type C, Mil-Std-1276

HOW TO SPECIFY

PPR5000 Series Resistors can be completely specified using the following designation:

50	7	3	P	E	10K0	B
Fixed Film Resistor	**Wattage** 7 = 1 8 = 2 9 = 3 A = 5	**Encapsulation** 3 = Conformal	**Style**	**Temperature Coefficient (PPM/°C)** G = ±20 ppm = T14 E = ±25 ppm = T9 C = ±50 ppm = T2 D = ±100 ppm = T0	**Resistance Value** R = Ohm K = 1,000 Ohms 49R90 = 49.9 Ohms 100K0 = 100 K Ohms	**Tolerance** A = ±.05% B = ±.1% C = ±.25% D = ±.5% F = ±1%

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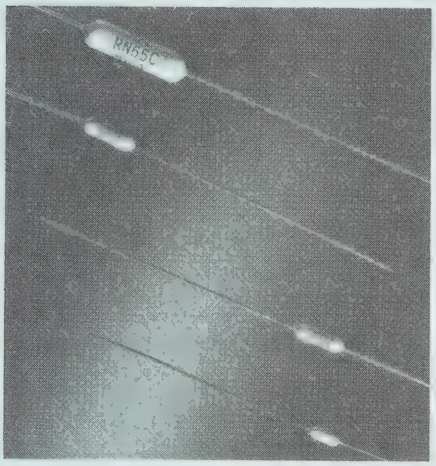
RN SERIES
CUSTOM MATCHED SETS

Resistance Ratio Match to .10%, Temperature Coefficient Match to 10 PPM/C°



±0.1%, 0.25%, 0.5%, and 1% Tolerance
Characteristics C (±50PPM), and E (±25PPM)
1/20, 1/10, 1/8, 1/4, 1/2 Watt (125°C)
1/10, 1/8, 1/4, 1/2, Watt (70°)

DESCRIPTION

For applications not requiring the ultra precision & stability of the UPR 5000Z series, the RN series of custom matched sets provide a very economical alternative. The RN series, with broad selections of tolerances, temperature coefficient characteristics, resistance values, and power ratings, is available in matched sets with resistance ratio tolerances to .1% and temperature coefficient matches to 10PPM/C°.

PACKAGING

Coin Envelope, stamped with "Matched Set-Do Not Separate" and customer part number.

DESIGN FEATURES

- Excellent Initial Accuracy and Long-Term Stabilities, approaching wirewound resistor performance.
- Lowest Voltage and Power Coefficients ever attained in a metal-film resistor.
- Low Temperature Coefficients. Characteristic E equals the performance of conventional wirewound designs.
- Excellent Matching and Tracking. Tolerance of 0.1%, 0.25%, 0.5%, 1%, and TC tracks of 10PPM, 25PPM and 50PPM/°C are available.
- Very Low Reactance-low series L, low shunt C; reactance error is generally less than tolerance up to 10 MHz, for most resistance values.

MATCHED SET REQUIREMENTS ARE UNIQUE TO THE CUSTOMER SPECIFICATION
APPLICATION ENGINEERING ASSISTANCE IS AVAILABLE BY CALLING OR WRITING THE FACTORY

SPECIFICATIONS AND NOMENCLATURE

Philips Style	Power Rating (Watts) MIL-R-10509		Power Rating (Watts) Philips Components	Resistance Range (ohms)	Temperature Coefficient (PPM/°C)	Resistance Tolerance	RN Matched Set Configurations	
	125°C	70°C	70°C				*Resistance Ratio Match	*Temperature Coefficient Track
5023R	1/20	1/10	1/8	30.1Ω to 301K	±25PPM ±50PPM	±0.1% to ±1.0%	.10% .25% .50% 1.00%	10PPM 25PPM 50PPM
5033R	1/10	1/8	1/4	49.9Ω to 750K	±25PPM ±50PPM	±0.1% to ±1.0%		
5043R	1/8	1/4	1/2	30.1Ω to 1M	±25PPM	±0.1% to ±1.0%		
				30.1Ω to 2M	±50PPM			
5053R	1/4	1/2	1	49.1Ω to 1M	±25PPM	±0.1% to ±1.0%	*Most common configurations other combinations available	
				49.9Ω to 4M	±50PPM			

UPR SERIES
CUSTOM MATCHED SETS

Resistance Ratio Match to .02%, Temperature Coefficient Match to 2 PPM/C°

DESCRIPTION

Philips Components offers the superior stability of the 5000Z series in custom factory matched sets to achieve maximum precision of resistance ratio at minimum cost. The 5000Z sets are available with absolute resistance tolerance of ±.02%, resistance ratio matches to .02% and temperature coefficient tracking to 2PPM/°C. The combination of rapid response time, stability, low noise, precision and low cost make these sets the outstanding value for precision analog circuitry.

PACKAGING

Coin Envelope, stamped with "Matched Set-Do Not Separate" and customer part number.

DESIGN FEATURES

- Temperature Coefficients and Tolerances approaching the lowest attainable in resistor technology.
- Excellent Temperature and Time Stabilities, equivalent to the best competitive devices.
- Lowest Voltage and Power Coefficients ever attained in metal film resistors.
- Low noise. Johnson noise is unmeasurable with existing techniques.
- High Initial Accuracy and Tracking. Tolerance matches of .02% and TC tracks of 2PPM/C° are available.
- Very Low Reactance—low series L, low shunt C: Reactance error is generally less than tolerance up to 10MHz, for most resistance values.

MATCHED SET REQUIREMENTS ARE UNIQUE TO THE CUSTOMER SPECIFICATION
APPLICATION ENGINEERING ASSISTANCE IS AVAILABLE BY CALLING OR WRITING THE FACTORY

SPECIFICATIONS AND NOMENCLATURE—5000Z MATCHED SETS

Philips Components Style	Maximum Power Rating (85°C)	Resistance Range (ohms)	Temperature Coefficient (PPM/°C)	Resistance Tolerance	5000Z Matched Set Configuration	
					*Resistance Ratio Match	*Temperature Coefficient Track
5013Z	1/20 WATT	51.1Ω to	±2PPM (100Ω-301K)	±.02%	.0.02%	2PPM
5023Z	1/8 WATT	511KΩ		±.025%	0.05%	5PPM
5033Z	1/4 WATT		±5PPM	±.05%	0.10%	10PPM
5063Z	1/3 WATT		±10PPM	±.10%		
			±15PPM	±.25%	*Most common configurations other combinations available	
			±20PPM	±.5%		
			±25PPM	±1.0%		

6

Fixed Resistors

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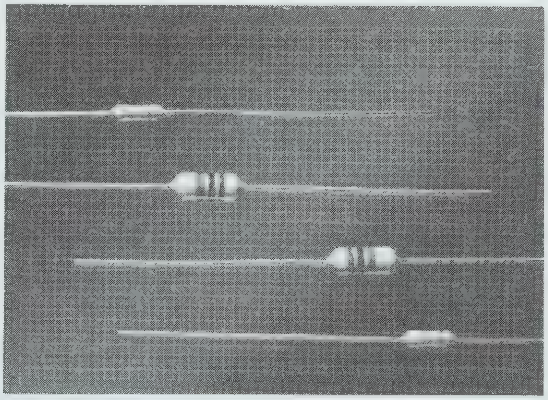
Standard Military Resistors Conformal-Coated (MIL-R-22684)

2% and 5% Tolerance 100 PPM Temperature Coefficient
1/4 and 1/2 Watt (70°C)



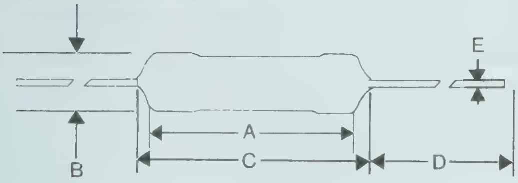
DESCRIPTION

This RL Series comprises MIL-R-22684 resistors of moderate accuracy and good stability, and is particularly suited to replacement of RL-type metal-glaze or tin-oxide resistors where higher stability, lower noise, and better voltage/power coefficients are required in the same or smaller space. Over a very broad frequency spectrum, these resistors exhibit negligible reactance, and are entirely suitable for fast-pulse circuitry.

DESIGN FEATURES

- Lowest Voltage and Power Coefficients ever achieved in metal-film resistors.
- Excellent Temperature/Time Stability—significantly better than that achieved by other film resistors in the RL class.
- Low Noise—Johnson noise is lowest attainable, except in best wirewound designs.
- Very Low Reactance—Low Series L, low shunt C; reactance error is generally less than tolerance up to 10 MHz, for most resistance values.

DIMENSIONS



SPECIFICATIONS & NOMENCLATURE–RL (5000T) SERIES

MIL Type	Philips Style	MIL Power Rating (70°C)	Resistance Range* (ohms)	Temperature Coefficient (PPM/°C)	Resistance Tolerance	Max. Voltage (Volts)	Dimensions—See Diagram Inches (mm)				
							A	B	C**	D	E (AWG)
RL07	5043T	1/4 W	51Ω to 150K	±100PPM	±2% ±5%	250V	.261±.020 (6.63±0.51)	.093±.005 (2.36±0.13)	.300 Max. (7.62)	1.5 (38.1)	.025 (.63) (#22)
RL20	5053T	1/2 W	4.3Ω to 470K	±100PPM	±2% ±5%	350V	.390±.020 (9.91±0.51)	.152±.009 (3.86±.23)	.430 Max. (10.92)	1.5 (38.1)	.032 (.81) (#20)

*Within the resistance ranges shown, values indicated in the decade table of values and their decade multiples, are available as standard. Other values are available on special order.
**Clean-lead to clean-lead.

MIL STYLE RL

Standard Military Resistors Conformal-Coated (MIL-R-22684)

PERFORMANCE CHARACTERISTICS

As a guide to the performance that can be expected of RL Series resistors, the following chart indicates typical results of tests performed in accordance with MIL-R-22684.

	Max. % Change in Resistance	
	MIL-R-22684 Requirements	M/C RL Average
Temperature Cycling, −55° to +85°C	.1%	.05%
Low temperature operation, −65°C	.5%	.03%
Short time overload	.5%	.05%
Terminal strength, 5 lb. load	.5%	.02%
Dielectric withstanding Voltage	.5%	.02%
Resistance to soldering heat, 350°C	.5%	.08%
Moisture resistance	1.5%	.20%
Life (1,000 hours)	.2%	.15%
Shock (Specified pulse 100G, 6 ms)	.5%	.03%
Vibration, High frequency 10-2000 Hz	.5%	.03%

MARKING

RL Series resistors are marked using 5 color bands per MIL-R-22684.

PACKAGING

Bulk (100 pieces per box) or Lead Tape and Reel per EIA RS-296D.

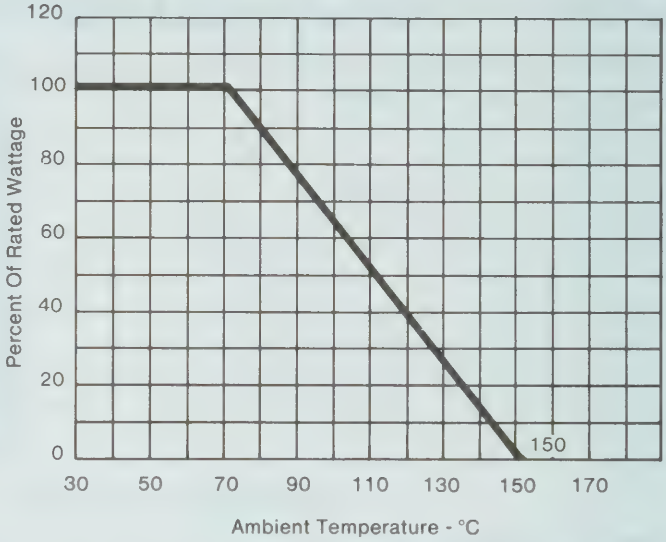
LEAD MATERIAL

Type C, MIL-STD-1276 (tin-lead plating over Oxygen-free high conductivity Copper).

typical capacitance values

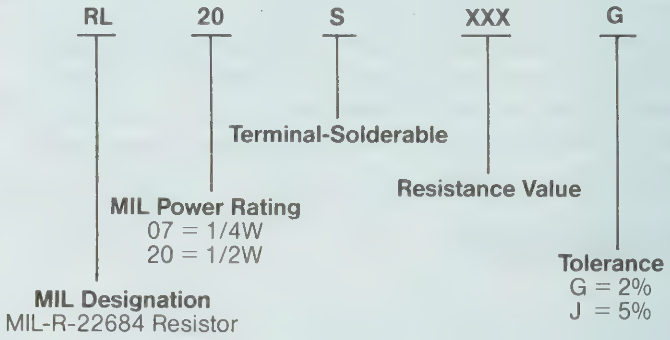
Style	5043T	5053T
C (pF) ±25%	0.18	0.21
Voltage Coefficient (PPM/Volt) ±25%	5	3
Power Coefficient (°C/Watt) ±10%	130	150

DERATING CURVE



HOW TO SPECIFY

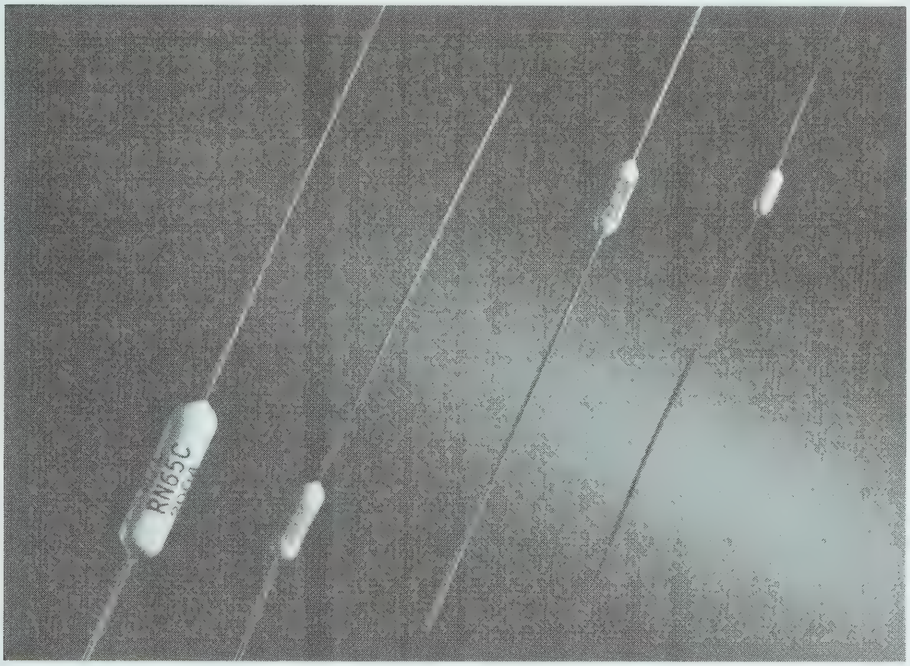
MIL STYLE RL Resistors can be completely specified using the following designation.



6 Fixed Resistors

Standard Military Resistors Conformal-Coated (MIL-R-10509 Qualified)

±0.1%, 0.25%, 0.5%, and 1% Tolerance Characteristics
E (±25PPM), C ±50PPM, and D (±100PPM)



DESCRIPTION

This Series encompasses an unusually broad selection of tolerances, temperature characteristics, and power ratings, in all their combinations, with full MIL-R-10509 performance. Typically the MIL requirements are exceeded to a substantial degree. These resistors feature the low noise, high stability and wide operating frequency range characterizing the Philips Components metal-film design, in minimum size for their power ratings.

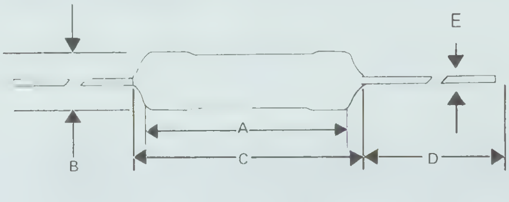
DESIGN FEATURES

- Excellent Initial Accuracy and Long-Term Stabilities, approaching wirewound resistor performance.
- Lowest Voltage and Power Coefficients ever attained in a metal-film resistor.
- Low Temperature Coefficients. Characteristic E equals the performance of conventional wirewound designs.
- Excellent Matching and Tracking. Tolerances of 0.1%, 0.25%, 0.5% and 1% are standard. Ratio sets track closely over wide temperature ranges, long term.
- Very Low Reactance—low series L, low shunt C; reactance error is generally less than tolerance up to 10MHz, for most resistance values.

MIL STYLE RN

Standard Military Resistors Conformal-Coated (MIL-R-10509)

DIMENSIONS



SPECIFICATIONS & NOMENCLATURE–RN (5000R/M) SERIES

MIL (QPL) Type	Philips Style	Power Ratings (Watts) Commercial 70°C	MIL-R-10509 125°C	MIL-R-10509 70°C	Qualified (QPL) Resistance Range (ohms)†	Philips Components Resistance Range (ohms)†	Temperature Coefficient (PPM/°C)	Resistance Tolerance	Max Voltage	Dimensions—See Diagram Inches (mm) A	B	C**	D	E
RN50	5023R	1/8	1/20		30.1Ω-100K	10Ω750K	E = ±25PPM	±0.1% ±0.25% ±0.5% ±1.0%	200	.150±.020 (3.81 ±0.51)	.070±.010 (1.79 ±0.23)	200 (5.08)	1.5 (38.1)	.016" (.41) (#26)
					30.1Ω-100K	10Ω750K	C = ±50PPM							
				1/10	*	10Ω-750K	D = ±100PPM							
RN55	5033R	1/4	1/10		49.9Ω-100K	10Ω-1M	E = ±25PPM	±0.1% ±0.25% ±0.5% ±1.0%	200 E C	.261±.020 (6.63 ±0.51)	.093±.005 (2.36 ±0.13)	.300 (7.62)	1.5 (38.1)	.025" (.63) (#22)
					49.9Ω-100K	10Ω-2M	C = ±50PPM							
				1/8	10Ω-300K	1Ω-2M	D = ±100PPM		250 D					
RN60	5043M	1/2	1/8		49.9Ω-499K	30.1Ω-1M	E = ±25PPM	±0.1% ±0.25% ±0.5% ±1.0%	250 E C	.303±.020 (7.70 ±0.50)	.104±.010 (2.64 ±0.25)	.350 (8.89)	1.5 (38.1)	.025" (.63) (#22)
					49.9Ω-499K	30.1Ω-1M	C = ±50PPM							
				1/4	10Ω-1M	10Ω-2M	D = ±100PPM		300 D					
RN60	5043R	1/2	1/8		49.9Ω-499K	30.1Ω-1M	E = ±25PPM	±0.1% ±0.25% ±0.5% ±1.0%	250 E C	.390±.020 (9.91 ±0.51)	.152±.009 (3.86 ±0.23)	.430 (10.92)	1.5 (38.1)	.025" (.63) (#22)
					49.9Ω-499K	30.1Ω-2M	C = ±50PPM							
				1/4	10Ω-1M	1Ω-2M	D = ±100PPM		300 D					
RN65	5053R	1	1/4		49.9Ω-1M	49.9Ω-2M	E = ±25PPM	±0.1% ±0.25% ±0.5% ±1.0%	300 E C	.620±.020 (15.75 ±0.51)	.167±.010 (4.24 ±0.26)	.650 (16.51)	1.5 (38.1)	.025" (.63) (#22)
					49.9Ω-1M	49.9Ω-4M	C = ±50PPM							
				1/2	10Ω-2M	1Ω-4M	D = ±100PPM		350 D					

*MIL-R-10509 does not include a RN50, for 100PPM Temperature Coefficient.
**Clean-lead to clean-lead.
†Within the resistance ranges shown, values indicated in the decade table of values and their decade multiples, are available as standard. Other values are available on special order.

6 Fixed Resistors

MIL STYLE RN

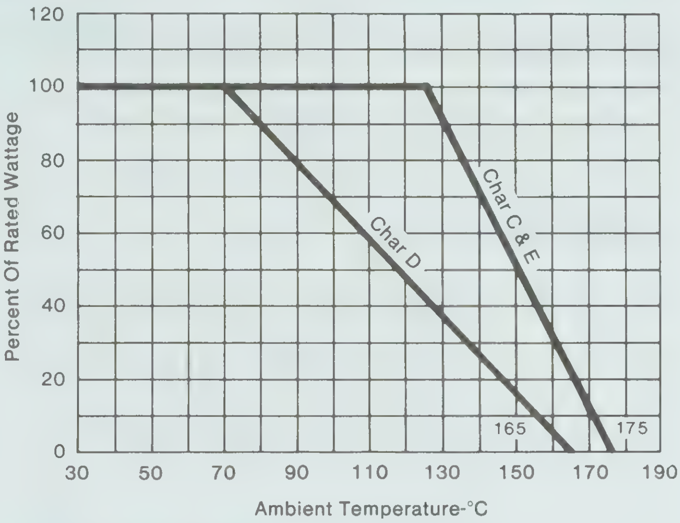
Standard Military Resistors Conformal-Coated (MIL-R-10509)

PERFORMANCE CHARACTERISTICS

As a guide to the performance that can be expected of RN Series resistors, the following chart indicates typical results of tests performed in accordance with MIL-R-10509.

Test	Max. % Change in Resistance: MIL-R-10509 (Characteristics C & E) Requirements	Philips Components RN—Series Average
Temperature Cycling, −65 to +150°C	.25%	.05%
Low temperature operation, −65°C*	.25%	.02%
Short time overload	.25%	.02%
Terminal strength, 5 lb. load	.2%	.02%
Dielectric withstanding Voltage	.25%	.01%
Resistance to soldering heat, 350°C	.10%	.01%
Moisture resistance	.50%	.05%
Life (1,000 hours)	.50%	.10%
Shock, medium impact, 50G, 11 ms.	.25%	.01%
Vibration, High frequency 10-2000 Hz	.25%	.01%

DERATING CURVE



MARKING

Standard military RN Series resistors are marked with the MIL style, characteristic, resistance, and tolerance, as specified in MIL-R-10509. (See JAN Marking)

PACKAGING

Bulk (100 pieces per box) or Lead Tape and Reel per EIA RS-296D.

LEAD MATERIAL

Type C, MIL-STD-1276 (tin-lead plating over Oxygen-free high conductivity Copper).

typical capacitance values.

Philips Style	5023R	5033R	5043M	5043	5053R
C (pF) ±25%	0.18	0.18	0.19	0.21	0.33
Voltage Coefficient (PPM/Volt) ±25%	6	5	4	3	2
Power Coefficient (°C/Watt) ±10%	220	130	120	93	75

MIL-R-10509 "J" OR "JAN" MARKING

The Defense Electronics Supply Center (D.E.S.C.) has stated that all MIL-R-10509 qualified products, manufactured after January 4, 1982 must be marked with the "J" or "JAN" marking to prevent the sale of non-qualified product as qualified product.

HOW TO SPECIFY

MIL STYLE RN Resistors can be completely specified using the following designation:

RN 60 D XXXX F

Temperature Coefficient (D)
E = ±25 PPM/°C
C = ±50 PPM/°C
D = ±100 PPM/°C

MIL Power Rating (60)

	125°C	70°C
50 =	1/20W	1/10W
55 =	1/10W	1/8W
60 =	1/8W	1/4W
65 =	1/4W	1/2W

MIL Designation (RN)
MIL-R-10509 Resistor

Resistance Value (XXXX)
XXRX<100
XXXX≥100

Tolerance (F)
B ±0.1%
C ±0.25%
D ±0.5%
F ±1%

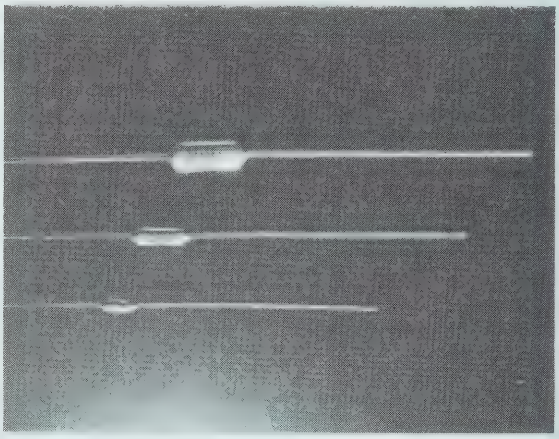
*Power Rating is Dependent on Temperature Coefficient. See Specifications And Nomenclature.

MIL-R-10509 has limited resistance ranges (compared to MIL-R-55182. Philips Components' policy is to supply products qualified to MIL-R-10509 with the JAN marking. Resistance values above or below those specified in MIL-R-10509, where Philips Components testing demonstrates the capability of meeting the performance requirement of MIL-R-10509, will be marked in accordance with MIL-R-10509 but without the JAN marking.

MIL STYLE RLR

Established Reliability Resistors Conformal-Coated (MIL-R-39017)

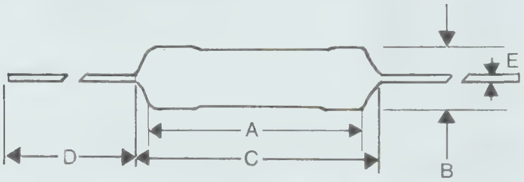
±2%, ±1% Tolerance ±100PPM Temperature Coefficient
1/8, 1/4 and 1/2 Watt (70°C)
Failure Rate "S" (0.001% per 1000 Hours)



DESCRIPTION

The RLR Series provide the highest attainable margins of reliability in this class of resistors—performance substantially better than that required by MIL-R-39017 (RLR). This design offers moderate accuracy and good stability, and is particularly suited to replacement of carbon-film, carbon-composition, or even conventional metal-film resistors, where the ultimate in reliability, as well as higher stability, lower noise, and low voltage/power coefficients are required, in the same or smaller space. Over a very broad frequency spectrum, these resistors exhibit negligible reactance, and are entirely suitable to fast-pulse circuitry. Philips Components' established-reliability program, which operates in full conformance with MIL-STD-790, attains unprecedented reliability levels for RLR Series resistors.

DIMENSIONS



DESIGN FEATURES

- Lowest Voltage and Power Coefficients ever attained in a metal-film resistor.
- Low Noise. Johnson noise is lowest attainable, except in best wirewound designs.
- Wide Resistance Range: 4.3 Ohms to 1.33 Megohms.
- Excellent Immunity to Environmental Stress. Highest reliability in this class.
- Very Low Reactance—low series L, low shunt C; reactance error is generally less than tolerance up to 10MHz, for most resistance values.

6

Fixed Resistors

SPECIFICATIONS & NOMENCLATURE–RLR (5000U) SERIES

MIL (QPL) Type	Philips Components Style	MIL Power Rating (70°C)	*Qualified (QPL) Resistance Range (ohms)	Temperature Coefficient (PPM/°C)	Resistance Tolerance	Life-Failure Rate (Per 1000 hrs.)	Voltage (Volts)	Dimensions—see diagram Inches (mm) A	B	C** Max.	D	E (AWG)
RLR05	5033U	1/8W	10Ω to 750K	±100 PPM	±1% ±2%	S = 0.001% R = 0.01% P = 0.1% M = 1.0%	200	.150 ±.020 (3.8) (±.51)	.066 ±.008 (1.68) (±.20)	.187 (4.75)	1.25 ±266 (31.8) (±6.76)	.016 (.41) (#26)
RLR07	5043U	1/4W	10Ω to 1.33M	±100 PPM	±1% ±2%	S = 0.001% R = 0.01% P = 0.1% M = 1.0%	250	.261 ±.020 (6.63 ±0.51)	.093 ±.005 (2.36 ±0.13)	.300 (7.62)	1.5 (38.1)	.025 (.63) (#22)
RLR20	5053U	1/2W	4.3Ω to 1M	±100 PPM	±1% ±2%	S = 0.001% R = 0.01% P = 0.1% M = 1.0%	350	.390 ±.020 (9.91 ±0.51)	.152 ±.009 (3.86 ±0.23)	.430 (10.92)	1.5 (38.1)	.032 (.81) (#20)

*Within resistance ranges shown, values indicated in the decade table of values and their decade multiples, are available as standard. Other values are available on special order.
**Clean-lead to clean-lead.

MIL STYLE RLR

Established Reliability Resistors Conformal-Coated (MIL-R-39017)

PERFORMANCE CHARACTERISTICS

As a guide to the performance that can be expected of RLR Series resistors, the following chart indicates typical results of tests performed in accordance with MIL-R-39017.

Test	Max. % Change in Resistance — MIL-R-39017 Requirements	Max. % Change in Resistance — RLR Series Average
Power conditioning 150% max W.	.5%	.10%
Thermal Shock, −55 to +150°C	.25%	.05%
Low temperature operation, −55°C	.25%	.03%
Short time overload	.5 %	.05%
Terminal strength, 5 lb. load	.25%	.02%
Dielectric Withstanding Voltage	.25%	.02%
Resistance to soldering heat, 350°C	.25%	.02%
Moisture resistance	1%	.20%
Life (2,000 hours)	2%	.15%
Shock, medium impact, 50G, 11ms.	.5%	.03%
Vibration, High frequency 10-2000Hz	.5%	.03%
High tem. exposure 150°C/2000 hrs.	2%	.15%

RLR Series resistors are marked with the type designation, JAN marking, date code, source code, and manufacturer's production lot code, as specified by MIL-R-39017.

PACKAGING

Bulk (100 pieces per box) or Lead Tape and Reel per EIA RS-296D. Custom packaging available per customer requirements.

LEAD MATERIAL

Type C, MIL-STD-1276 (tin-lead plating over Oxygen-free high conductivity Copper).

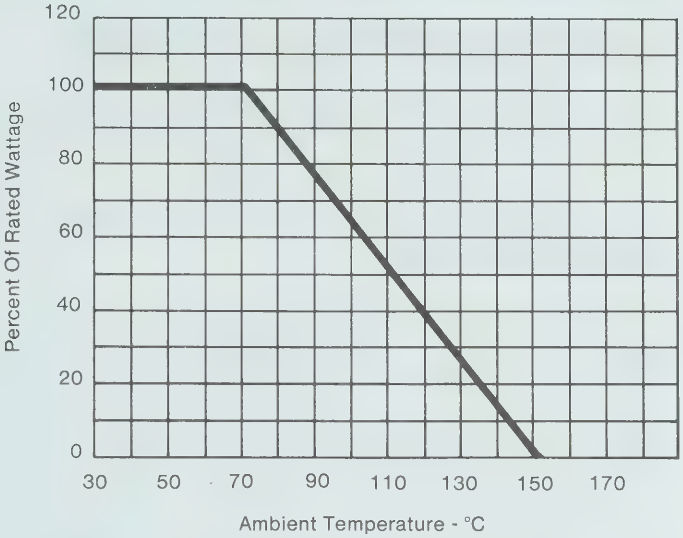
Philips Style	typical capacitance values 5033U	5043U	5053U
C (pF) ±25%	0.18	0.15	0.21
Voltage Coefficient (PPM/Volt) ±25%	6	5	3
Power Coefficient (°C/Watt) ±10%	220	130	150

MIL-R-39017 PLUS

Additional screening (100 hour burn-in, thermal shock, X-ray, and serialization or other custom marking) is available per customer specifications.

NOTE: Only resistors made to the *exact* specifications of MIL-R-39017 may be JAN marked.

DERATING CURVE



HOW TO SPECIFY

MIL STYLE RLR Resistors can be completely specified using the following designation:

RLR 20 C XXXX G S

- **RLR** — **MIL Designation**: MIL-R-39017 Resistor
- **20** — **MIL Power Rating**: 05 = 1/8W; 07 = 1/4W; 20 = 1/2W
- **C** — **Terminal Solderable/Weldable**: Type C
- **XXXX** — **Resistance Value**: XXRX < 100; XXXX ≥ 100
- **G** — **Tolerance**: F = 1%; G = 2%
- **S** — **Life Failure Rate**: S = .001%/1000 HRS; R = .01%/1000 HRS; P = 0.1%/1000 HRS; M = 1.0%/1000 HRS

6

Fixed Resistors

MIL STYLE RNC

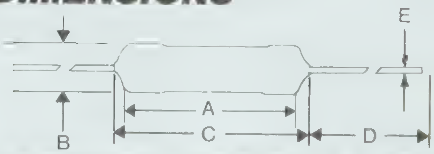
Established Reliability Resistors Conformal Coated (MIL-R-55182)

±0.1%, 0.5%, and 1% Tolerances
Characteristics J (±25PPM), H (±50PPM), K (±100PPM)
1/20, 1/10, 1/8, and 1/4 Watt (125°C)
1/10, 1/8, 1/4 and 1/2 W (70°C)
Failure Rate—"S" (0.001% Per 1000 Hours)

DESCRIPTION

These resistors provide substantial margins of reliability above and beyond those implicit in the stringent requirements of MIL-R-55182, and a wide choice of power ratings, tolerances, temperature coefficients, and resistance values. Philips Components' established-reliability program—the most experienced and respected in the industry—ensures unprecedented freedom from failure or performance anomaly. These resistors are manufactured by procedures that are in full conformance with MIL-STD-790. They feature the low noise, high stability, and wide operating frequency range that characterize Philips Components' metal-film designs, in minimum size for their power ratings.

DIMENSIONS



DESIGN FEATURES

- Excellent Initial Accuracy and Long-Term Stabilities, approaching wirewound resistor performance.
- Lowest Voltage and Power Coefficients ever attained in a metal-film resistor.
- Low Temperature Coefficients. Characteristic J equals the performance of conventional wirewound designs.
- Low Noise. Johnson noise is lowest attainable, except in best wirewound designs.
- Excellent Immunity to Environmental Stress. Highest reliability in this class.

SPECIFICATIONS & NOMENCLATURE—RNC (5000V) SERIES

MIL (QPL) Type	Philips Components Style	MIL Power Rating 125°C 70°C	*Qualified (QPL) Resistance Range (ohms)	Temperature Coefficient (PPM/°C)	Resistance Tolerance	Life Failure Rate (Per 1000 hrs)	Max Voltage (Volts)	Dimensions See Diagram Inches (mm)				
								A	B	C** MAX	D	E (AWG)
RNC50	5013V	1/20W 1/10W	10Ω to 750K	J = ±25PPM H = ±50PPM K = ±100PPM	±0.1% ±0.5% ±1.0%	S = 0.001% R = 0.01% P = 0.1% M = 1.0%	200VDC	.150 ±.020 (3.81) (±0.5)	.070 ±.010 (1.78) (±0.3)	.200 (5.1)	1.25 ±.266 (31.8) (±6.76)	.016 (.41) (#26)
RNC55	5023V	1/10W 1/8W	10Ω to 1M	J = ±25PPM H = ±50PPM K = ±100PPM	±0.1% ±0.5% ±1.0%	S = 0.001% R = 0.01% P = 0.1% M = 1.0%	200VDC	.261 ±.020 (6.63) (±0.5)	.093 ±.005 (2.36) (±0.13)	.300 (7.62)	1.5 (38.1)	.025 (.63) (#22)
RNC60	5033V	1/8W 1/4W	24.9Ω to 3.01M	J = ±25PPM H = ±50PPM K = ±100PPM	±0.1% ±0.5% ±1.0%	S = 0.001% R = 0.01% P = 0.1% M = 1.0%	250VDC	.390 ±.020 (9.91) (±0.5)	.152 ±.009 (3.86) (±0.23)	.430 (10.92)	1.5 (38.1)	.025 (.63) (#22)
RNC65	5043V	1/4W 1/2W	30.1Ω to 3.01M	J = ±25PPM H = ±50PPM K = ±100PPM	±0.1% ±0.5% ±1.0%	S = 0.001% R = 0.01% P = 0.1% M = 1.0%	300VDC	.595 ±.020 (15.11) (±0.5)	.163 ±.006 (4.14) (±0.15)	.637 (16.18)	1.5 (38.1)	.025 (.63) (#22)

*Within the resistance ranges shown, values indicated in the decade table or value and their decade multiples are available as standard. Other values are available on special order. **Clean-lead to clean-lead.

MIL STYLE RNC

Established Reliability Resistors Conformal-Coated (MIL-R-55182)

PERFORMANCE CHARACTERISTICS

As a guide to the performance that can be expected of the RNC Series resistors, the following chart indicates typical results of tests performed in accordance with MIL-R-55182.

	Max. % Change in Resistance	
	MIL-R-55182 Requirements	RNC Series Average
Thermal Shock & Overload, −65°C to +150°C	.2%	.02%
Low temperature operation, −65°C	.15%	.05%
Terminal strength	.2%	.02%
Dielectric Withstanding Voltage	.15%	.02%
Resistance to soldering heat, 350°C	.1%	.05%
Moisture resistance	.4%	.20%
Life 2,000 hours	.5%	.10%
10,000 hours	2.0%	.25%
Shock, (specified pulse)	.2%	.02%
Vibration, High frequency 10-2000Hz, 20G	.2%	.02%
High Temp. Exposure 175°C, 2000 hours	.5%	.35%

MARKING

Established-Reliability Series resistors are marked with the MIL type designation, JAN marking, date code, source code, and manufacturer's production lot code, in compliance with MIL-R-55182.

PACKAGING

Bulk (100 pieces per box) or Lead Tape and Reel per EIA RS-296D. Custom packaging available per customer requirements.

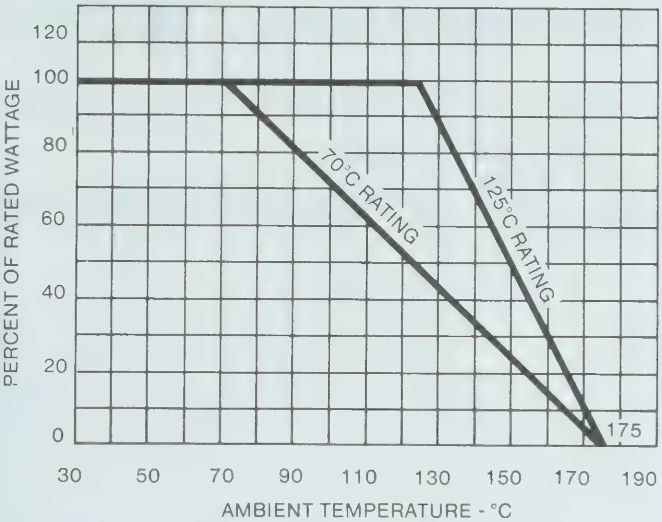
LEAD MATERIAL

Type C, MIL-STD-1276 (tin-lead plating over Oxygen-free high conductivity Copper).

typical capacitance values.

Philips Style	5013V	5023V	5033V	5043V
C(pF) ±25%	0.18	0.18	0.21	0.33
Voltage Coefficient (PPM/Volt) ±25%	6	5	3	2
Power Coefficient (°C/Watt ±10%	220	130	93	75

DERATING CURVE



HOW TO SPECIFY

MIL STYLE RNC Resistors can be completely specified using the following designation:

RNC 50 H XXXX F S

Resistance Value
XXRX <100
XXXX ≥100

Temperature Coefficient
J ±25PPM/°C
H ±50PPM/°C
K ±100PPM/°C

Power Rating

	125°C	70°C
50 =	1/20W	1/10W
55 =	1/10W	1/8W
60 =	1/8W	1/4W
65 =	1/4W	1/2W

Tolerance
B ±0.1%
D ±0.5%
F ±1.0%

Lead Configuration
RNC = Solderable/Weldable (Type C)*
RNR = Solderable

Life Failure Rate
S = 0.001%/1000 HRS
R = 0.01%/1000 HRS
P = 0.1%/1000 HRS
M = 1%/1000 HRS

*MIL STD 1276

MIL-R-PLUS

Additional screening (100 hour burn-in, X-ray, and serialization or other custom marking) is available per customer specifications.

NOTE: Only resistors made to the *exact* specifications of MIL-R may be JAN marked.

RNR/RNN MIL STYLE

Established Reliability Resistors Hermetic Seal (MIL-R-55182)

±0.1%, 0.5% and 1% Tolerance
Characteristics E (±25PPM) and C(±50PPM)
1/10, 1/8, 1/4 Watt (125°C)
1/8, 1/4, 1/2 Watt (70°C)
Failure Rate "S" (0.001% Per 1000 Hours)

6

Fixed Resistors

DESCRIPTION

These hermetically sealed, inert-gas-filled premium resistors are the most reliable, most uniform, most stable metal-film devices ever produced in conformance with MIL-R-55182. For the most demanding applications in aerospace and weaponry systems, under the most hostile environments, the performance of Series RNR/RNN resistors have been proven superior to that of any other design in this class. These resistors exhibit the same low noise, high stability, and wide operating frequency range that distinguish the Philips Components metal-film design, in remarkably small sizes, considering the protection afforded by hermetic sealing.

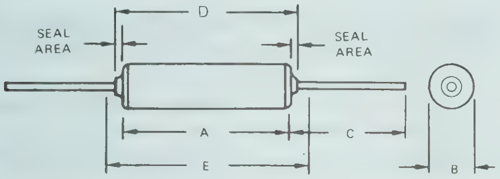
DESIGN FEATURES

- Excellent Immunity to Environmental Stress. Highest reliability in a metal-film resistor. Glass enclosure eliminates both moisture erosion and outgassing.
- Excellent Temperature and Time Stabilities, approaching those of wirewound resistors.
- Low Noise. Johnson noise is lowest attainable, except in best wirewound designs.
- Very Low Reactance—low series L, low shunt C; reactance error is generally less than tolerance up to 10MHz, for most resistance values.
- Low Voltage and Power Coefficients, approaching those of wirewound resistors of comparable size.

MIL STYLE RNR/RNN

Established Reliability Resistors (MIL-R-55182) Hermetic Seal

DIMENSIONS



SPECIFICATIONS & NOMENCLATURE–RNR/RNN (5000A) STYLE

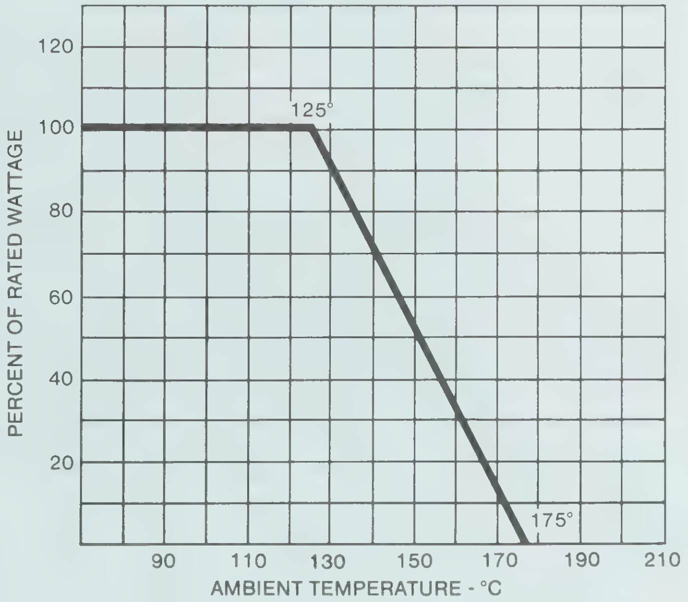
MIL (QPL) Type	Style	MIL Power Rating 125°C	70°C	*Qualified (QPL) Resistance Range (ohms)	Temperature Coefficient (PPM/°C)	Resistance Tolerance	Life Failure Rate (Per 1000 HRS)	Max. Voltage (Volts)	A Length	B Dia.	Dimensions—see diagram Inches (mm) C Leads (AWG)	D Case Length Plus Seal	E CL to CL**	Average Weight Grams*
RNR55 RNN55	5025A	1/10W	1/8W	10Ω to 1.21M	E = ±25PPM C = ±50PPM	±0.1% ±0.5% ±1.0%	S = 0.001% R = 0.01% P = 0.1% M = 1.0%	200	.272 ±.009 (6.91 ±0.29)	.110 ±.010 (2.79 ±0.25)	1.5 ±.125 (38.1 ±3.18) (#22)	320 (8.13)	.345 (8.76)	.3141
RNR60 RNN60	5035A	1/8W	1/4W	49.9Ω to 499K	E = ±25PPM C = ±50PPM	±0.1% ±0.5% ±1.0%	S = 0.001% R = 0.01% P = 0.1% M = 1.0%	250	.422 ±.015 (10.72 ±0.38)	.147 ±.003 (3.73 ±0.08)	1.5 ±.125 (38.1 ±3.18) (#22)	.500 (12.70)	.561 (14.25)	.4848
RNR65 RNN65	5045A	1/4W	1/2W	49.9Ω to 1M	E = ±25PPM C = ±50PPM	±0.1% ±0.5% ±1.0%	S = 0.001% R = 0.01% P = 0.1% M = 1.0%	300	.641 ±.015 (16.28 ±0.38)	.243 ±.008 (6.17 ±0.20)	1.5 ±.125 (38.1 ±3.18) (#22)	.740 (18.80)	.780 (19.80)	1.2597

*Within the resistance ranges shown, values indicated in the decade table values and their decade multiples, are available as standard. Other values are available on special order. **Clean-lead to clean-lead.

PERFORMANCE CHARACTERISTICS

As a guide to the performance that can be expected of RNR/RNN Series resistors, the following chart indicates typical results of tests performed in accordance with MIL-R-55182.

	Max. % Change in Resistance MIL-R-55182 Requirements	RNR Series Average
Thermal Shock & Overload, −65° to +125°C	.2%	.02%
Low temperature operation, −65°C	.15%	.05%
Terminal strength	.2%	.02%
Dielectric withstanding Voltage	.1%	.02%
Resistance to soldering heat, 350°C	.1%	.02%
Moisture resistance	.2%	.05%
Life 2,000 hours;	.5%	.10%
10,000 hours	2.0%	.20%
Shock, (specified pulse)	.2%	.02%
Vibration, High frequency 10-2000Hz, 20G	.2%	.02%
High Temperature Exposure 175°C, 2000 hrs	.5%	.20%



MIL STYLE RNR/RNN

Established Reliability Resistors (MIL-R-55182) Hermetic Seal

MARKING

Established-Reliability Series resistors are marked with the MIL type designation, JAN marking, date code, source code, and manufacturer's production lot code, in compliance with MIL-R-55182.

PACKAGING

Bulk (100 pieces per box) or Lead Tape and Reel per EIA RS-296D. Custom packaging available per customer requirements.

LEAD MATERIAL

RNR = Type N Gold Plated per MIL-STD-1276
RNN = Type N Gold Plated per MIL-STD-1276

typical capacitance values

Style	5025A	5035A	5045A
C (pF) ±25%	0.11	0.10	0.14
Voltage Coefficient (PPM/Volt) ±50%	2.0	0.5	0.2
Power Coefficient (°C/Watt) ±10%	140	170	120

MIL-R-55182 PLUS

Additional screening (100 hour burn-in, X-ray and serialization or other custom marking) is available per customer specifications.

NOTE: Only resistors made to the *exact* specifications of MIL-R-55182 may be JAN marked.

HOW TO SPECIFY

MIL STYLE RNR/RNN Resistors can be completely specified using the following designation:

RNR 55 C XXXX F S

Tolerance
B ±0.1%
D ±0.5%
F ±1.0%

Temperature Coefficient
E ±25PPM/°C
C ±50PPM/°C

MIL Power Rating

	125°C	70°C
55 =	1/10W	1/8W
60 =	1/8W	1/4W
65 =	1/4W	1/2W

Resistance Value
XXRX <100
XXXX ≥100

Lead Configuration
RNR = Solderable
RNN = Weldable

Life Failure Rate
S = 0.001%/1000 HRS
R = 0.01%/1000 HRS
P = 0.1%/1000 HRS
M = 1%/1000 HRS

BULK PACK

Resistors are packed 100 to a standard carton, either 1″ x 1″ or 1¾″ x 1¾″ by 3¾″ long, overall dimensions, depending upon the resistor size.

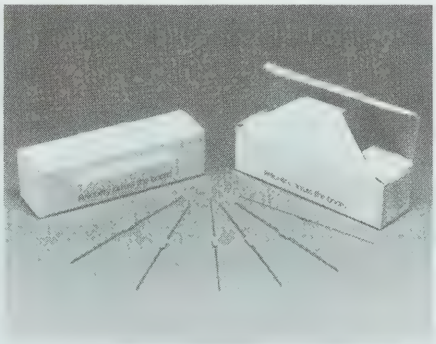


Figure 1. Bulk-Pack Resistor Cartons

INSERT CARD

Resistors are mounted in slotted cards, and locked in place by a card strip inserted beneath them. Up to 15 large, or 20 small resistors per card, readily amenable to bulk shipment.

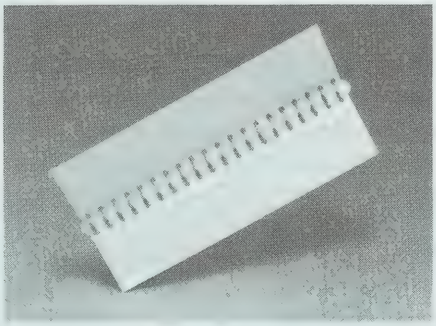


Figure 2. Insert Card Packs

LEAD TAPE EIA RS-296-D

Lead-taped resistors are packaged in the two formats following. In the Ammo Pack, the taped resistors are folded into cartons of (usually) 1000 resistors per tape. The Reel Pack holds up to 5000 resistors per tape, on a 12″ diameter reel.

Resistors can be furnished taped in a considerable variety of configurations, in either Ammo or Reel packs, to suit production-line requirements and dimensional specifications for the automatic insertion machinery employed.

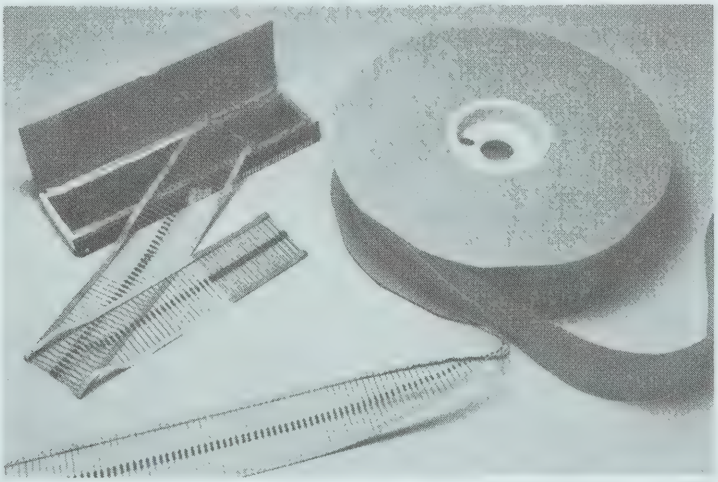


Figure 3. Lead-Taped Resistors in Ammo Pack (left) and Reel Pack (right) Formats.

ESD (Electro-Static Discharge) packaging is available. Please contact factory for details.

Design Data for Selecting and Applying Film Resistors

The Resistor has been with us ever since Georg Simon Ohm straightened out the R = E/I situation, early in the last century. For many decades, there was no appreciable demand for high-precision resistance; when the needs began to develop, it was often cheaper to make the essential values in-house, to add trimmers, or to design around them by placing the accuracy burden elsewhere in the circuit. Even today, there remains an inherent tendency to make do with resistance accuracies of ±20% or ±10% in many design areas, on the basis that, if you use a tighter-tolerance resistor, it won't stay that way very long, but it will add a considerable boost to your production costs.

A designer who thinks this way, without investigating the facts, does himself and his designs a serious disservice. Over the past thirty years, military and space program demands have sponsored a technological revolution in all of the disciplines. In the manufacture of resistors, we have developed new materials, new techniques and controls, and particularly new automatic test, sorting, and selection processes under computer control; exhaustive laboratory investigations and rigorous field tests have established an enormous fund of reliable technical information on the performance of resistors under all combinations of conditions—long term as well as short term. Such data are made available in condensed form in the specifications for each Philips Components resistor Series. Armed with these, and a familiarity with the *significance* of such ratings, as outlined in the pages that follow, the designer can both *extrapolate* the performance of a particular resistor to a given *set* of operating conditions, and *estimate* its performance over any anticipated *range* of conditions. He can confidently select a lower wattage, a different shape or size, a more-compatible characteristic, or a more economic style. He can unburden his circuits of the need for trimming or recalibration provisions by selecting a higher accuracy for certain critical resistors. This additional degree of freedom can pay off handsomely in improved performance, higher reliability, and in significant reductions in size, weight, and cost.

Design Data for Selecting and Applying Film Resistors

Resistor Parameters—Defined and Interpreted. Although the definitions that follow are widely accepted by the electronics engineering community as the most specific and useful means for describing the performance of a fixed resistor, it is unfortunately true that some manufacturers deviate from standard specification practice. Indeed, many of the parameters defined here are actually *omitted* from many resistor specifications.

Furthermore, this lack of industry-wide standardization has led to uncertainty, and even confusion, as to both the interpretation and the significance of certain specifications... to the detriment of the final circuit design. The reader is urged, therefore, to review these definitions, and to refer back to their interpretations, when evaluating and selecting resistors for his application.

Accuracy (Tolerance). The maximum deviation from the nominal value of the resistance, *at the standard trimming temperature,* measured at negligibly low test voltage and dissipation, usually expressed as a percentage of nominal resistance (or the equivalent in parts per million). *Initial* accuracy (the figure specified in a catalog) is the accuracy of the resistor at the time of shipment.

NOTES: The "standard trimming temperature" for Philips Components resistors is 23°C (73.4°F). Measurements at other ambient temperatures *must* allow for the temperature coefficient (T.C.) of the resistor. "Negligibly low test voltage and dissipation" means that the test voltage applied is not high enough to cause significant changes in resistance value, considering both the voltage coefficient of resistivity (defined elsewhere) and self-heating effects (see definition of power coefficient).

Temperature Coefficient (of Resistivity). The maximum change in resistance per unit change in the temperature of the resistor, usually expressed in (±) parts per million of nominal per degree Centigrade. Usually, a T.C. rating is associated with a specific temperature range, over which the maximum T.C. is never exceeded.

NOTES: The temperature reference in this specification is that of the *resistor,* not the ambient temperature... although, in the absence of self-heating, if the resistor has had time to reach thermal equilibrium with the ambient, the resistor temperature may be the same as the ambient temperature. The preferred test method is to measure resistance (at negligible dissipation) at several different temperatures, holding each temperature long enough for the resistance to stabilize. (See later discussion of power coefficient, for method of correction for significant dissipation.)

Time Stability. The degree to which the initial resistance value is maintained, to a stated degree of certainty (probability), under stated conditions of use, over a stated period of time; usually expressed in (±) percent or (±) per unit (ppm) change in resistance per 1000 hours of continuous use.

NOTES: This parameter is very dependent on the conditions of use, drift being at a minimum for nominal ambient temperature and negligible dissipation.

Power (Temperature-Rise) Coefficient. The maximum rise in "hot-spot" temperature of the resistor above ambient, per Watt of dissipation, assuming free-air convection, and negligible loss of heat through the leads, after thermal equilibrium has been reached usually expressed in °C/Watt.

NOTES: Remember that this coefficient relates the *rise* in temperature (*above* ambient) to the power dissipated in it. Thus, if the power coefficient is 80°C/Watt, the power dissipated is 0.5 Watts, and the ambient temperature is 50°C, the final equilibrium hot-spot temperature will be:

$$80°C \times 0.5 + 50°C = 90°C$$

Note also that a hot-spot temperature of 90°C constitutes a 67°C rise above the standard trimming temperature of 23°C.

Self-Heating Coefficient (of Resistivity). The maximum change in resistance due to temperature change caused by power dissipation, at constant ambient temperature, usually expressed in percent of per-unit (PPM) change in nominal resistance per Watt of dissipation.

NOTE: This parameter is actually the product of the Power Coefficient and the Temperature Coefficient.

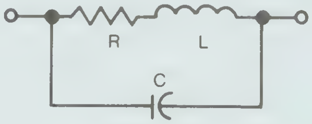
Voltage Coefficient (of Resistivity). The maximum change in nominal resistance due to the application of a voltage across the resistor, *after correcting for the self-heating effect,* usually expressed in percent or per-unit (PPM) change in nominal resistance per Volt applied.

Design Data for Selecting and Applying Film Resistors

NOTE: This relatively small error source is *not* due to heating, but rather to molecular distortion in the resistive material; however, an applied voltage *can* cause significant self-heating, and resistance changes due to temperature rise must be accounted for in measuring voltage coefficient. Voltage coefficient is also, to a very slight degree, a function of voltage *cycling* (repetitive application and removal of a voltage near the maximum rated voltage limit of the resistor).

AC/DC Impedance Ratio. The maximum ratio of the *magnitude* of the complex impedance (Z) to the DC resistance at the frequency of interest.

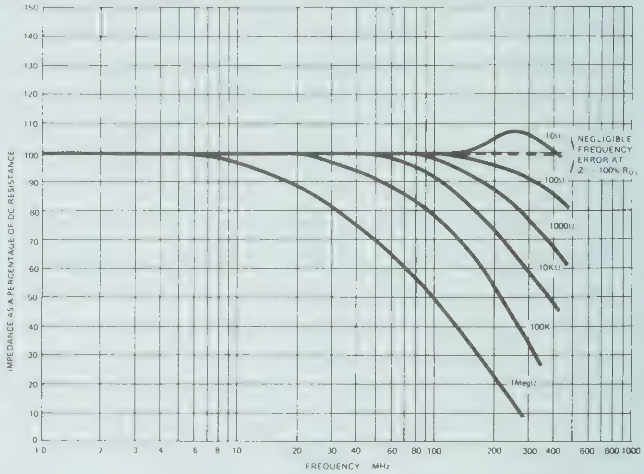
NOTES: The simple equivalent circuit of a resistor shown here is valid, for all Philips Components film resistors, over the entire frequency range from DC to hundreds of megahertz.



Because skin effect is negligible in all Philips Components film resistors, R, the resistive component of the impedance in the equivalent circuit, is constant at all frequencies. In almost all designs and resistance values, the inductance, L, has negligible effect up to several hundred megahertz. (The only exception to this statement is very low resistance values, of the order of 10-100 Ohms, in large wattage ratings, and then only above 100MHz.) The capacitance, C, however, may be significant, particularly in high-value resistors, at high frequencies. Generally speaking, the capacitance for any given style and wattage rating does not vary more than ±20% with the resistance value. In some of the individual resistor specifications, this capacitance is given for the styles and wattage ratings, to within ±25%. The AC/DC impedance ratio is then calculable from:

$$\frac{|Z|}{R} = \sqrt{\frac{1}{1 + (2\pi fRC)^2}}$$

where f is the frequency of interest. A family of typical curves of $\frac{|Z|}{R}$ *vs frequency for various resistance values are shown in the following column. Note that the 10Ω curve (only) shows appreciable series inductance, but only above 150MHz.*



"Useful" Frequency Range. This definition is arbitrary, because the range of usefulness depends on the nature of the application. In some applications, an AC/DC impedance ratio of 0.5 may be tolerable (e.g., in terminating certain filters), whereas in others, 0.99 may not be acceptable. At Philips Components the "useful" *precision* frequency range (for attenuators, voltage dividers, etc.) is defined very conservatively, by limiting it to *the highest frequency at which the impedance differs from the resistance by more than the tolerance of the resistor.* Thus, if a 1,000 Ohm, ±0.5% resistor has a nominal shunt capacitance of 0.5pF, then the "useful" frequency range is from DC to the frequency at which:

$$\left(1 - \frac{|Z|}{R}\right) = 0.5\%$$

$$\text{or: } \left(1 - \sqrt{\frac{1}{1 + (2\pi fCR)^2}}\right) = 5 \times 10^{-3}$$

from which f ≅ 2.5 MHz...although, as noted earlier, many applications can use such a resistor from DC to many times that frequency. Indeed, Philips Components film resistors are used in many applications approaching the *gigahertz* range...for example, the "useful" frequency range for terminating transmission lines and filter networks is at least 300MHz, between 50Ω and 1000Ω, the range of values most often used for this purpose.

6 **Fixed Resistors**

Design Data for Selecting and Applying Film Resistors

Failure Rate. The statistical probability of the incidence of "catastrophic" failure in a large number of identical resistors operated continuously for a given period of time under stated environmental conditions, usually expressed as maximum percentage of units predicted to fail under continuous service at maximum rated power (or voltage, if that limit is reached first), at 25°C ambient.

NOTES: The above definition is for an *industrial* failure-rate specification. MIL failure rates are established by the applicable MIL standards, to which the reader is referred. The "confidence level" implicit in the failure-rate calculation used to specify the reliability of Philips Components industrial resistors is 95%. Note also that "specification" failure rates (as opposed to catastrophic failure rates) may be significantly higher—i.e., a resistor may exceed its stability limits, as given by the preceding nomograph, without failing catastrophically.

Thermal Noise Level. The equivalent RMS voltage value, over a stated bandwidth, of all energy components generated by the resistor at a stated resistor temperature, with no externally supplied current flowing through the resistor.

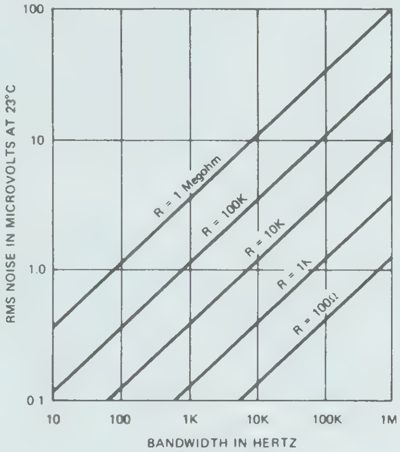
NOTES: The basic equation relating bandwidth, temperature, and noise in any resistor may be derived from the theoretical Johnson thermal-noise equation, and has the form:

$$E_{(RMS)} = 7.4\sqrt{RT\Delta f} \times 10^{-12}$$

where: R is the resistance in Ohms; T is the temperature in degrees Kelvin (°C+273); and Δf is the bandwidth in Hertz over which the noise energy is measured. See nomograph following for calculation of the magnitude of thermal noise, for *any* resistor. This inevitable thermal noise is sometimes called "white noise," because its energy level is the same at all frequencies. There is *another* noise component in film and composition resistors, called "current noise" or "1/f noise," the energy of which is inversely proportional to frequency, and is a function of both the current flowing in the resistor and the value of the resistor.

Current noise energy is almost exactly proportional, over wide ranges, to the square of the current flowing—i.e., to the square of the voltage across the resistor. Its variation with resistance, however, is a very complex function of the construction and metallurgy of the resistor. This parameter is discussed under Noise Index.

Noise Index. The ratio of the RMS current-noise voltage (over a one-decade bandwidth) to the average (DC) voltage caused by a specified constant current passed through the resistor, at a specified hot-spot temperature, usually expressed either in μV/Volt, or in decibels of voltage ratio:



$$\text{Noise Index} = 20\log_{10}\left(\frac{\text{Noise Voltage}}{\text{DC Voltage}}\right)$$

NOTES: A useful form of the above equation gives the total noise voltage for a given bandwidth, f_1 to f_2:

$$E_{RMS} = V_{DC} \times 10^{\left(\frac{N.I.}{20}\right)}\sqrt{\log\left(\frac{f_2}{f_1}\right)}$$

where V_{DC} is the IR drop across the resistor and N.I. is the Noise Index in dB. Test conditions must be controlled carefully, to assure that the specified hot-spot temperature is established. The measurement *must* be made on an instrument especially designed to permit correction for its own thermal noise, and the thermal noise of the resistor under test (usually negligible). If more than one decade of frequency is of interest, the RMS noise voltages add as the square root of the sum of the squares, so that the resultant multi-decade noise level is given by:

$$E_n = \sqrt{nE_1}$$

where E_n is the total voltage for n decades of frequency and E_1 is the noise voltage for one decade.

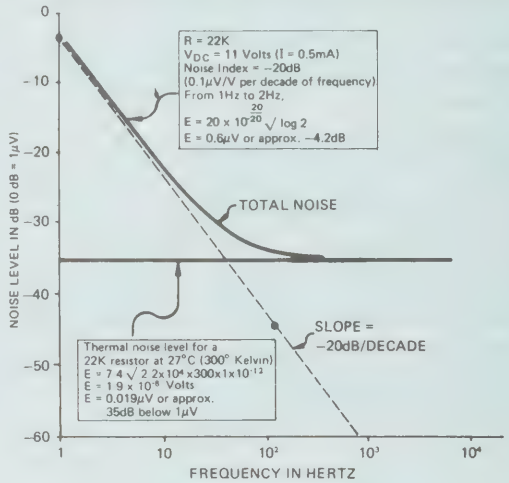
Design Data for Selecting and Applying Film Resistors

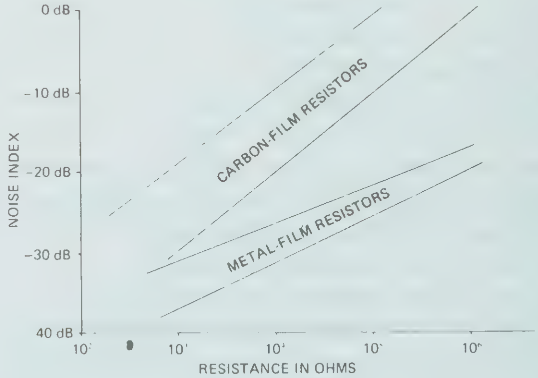
The curve at the top of the next column shows the relationship between noise level and frequency for a typical film resistor. At higher frequencies, the current noise approaches the thermal noise, and finally falls below it.

The curve following shows how noise index varies with resistance for typical Philips Components film resistors.

Second-Order and Third-Order Error Sources. These parameters are of limited interest, and are usually not specified, because they are not required for design evaluation, but are worthy of mention here, for consideration in the rare application in which they may acquire some significance. (NOTE: All MIL specifications incorporate tests of these effects.)

- Insulation Resistance. The minimum resistance between any point on the protective coating of a resistor and either of its terminals.
- Insulation Voltage Limit. The maximum voltage that may be impressed across the path from either terminal to any point on the protective coating of a resistor.
- Temperature Retrace. The maximum change in resistance value caused by a specified number of cycles in resistor hot-spot temperature (caused by dissipation and/or ambient temperature changes), usually expressed as: a percentage or per-unit (PPM) change from nominal resistance value (after "N" cycles between T_1 and T_2). **NOTE:** A special form of this test is the "Short-Term Overload" procedure.
- Voltage Retrace. The maximum change in resistance value caused by a specified number of cycles of application and removal of a specified voltage to the resistor, with the "on" and "off" times also specified, usually expressed as: a percentage or per-unit (PPM) change in nominal resistance value (after "N" cycles or "V", "on" for t_1 and "off" for t_2).
- Environmental Retrace. The maximum change in resistance value caused by a specified number of cycles of exposure of the resistor between two different sets of environmental-stress conditions (e.g., high to low humidity, with or without simultaneous temperature change; corrosive atmosphere, shock, vibration, etc.), expressed as a percentage or per-unit (PPM) change from the nominal resistance value (for "N" cycles between condition A, for a period of t_A, and condition B, for a period of t_B).
- Thermal Transient Response Time Constant. The maximum time required for the resistor to attain 63% of the steady-state (equilibrium) change in resistance from the initial value, as the result of suddenly (theoretically, *instantaneously*) changing either the ambient temperature or the dissipation, expressed in seconds. Note that this is a measure of the "thermal mass" of the resistor in its convection/conduction cooling environment, and the value measured may not correspond to that observed in practice, unless the environments are similar.





6

Fixed Resistors

Design Data for Selecting and Applying Film Resistors

RESISTANCE DESIGNATION

The code for specifying a resistor in any Philips Components Series is described in the catalog pages for that Series. The desired resistance value, in Industrial/Consumer types, is usually designated by standard nomenclature (i.e.: 15.4Ω, 5.1K, 1.0M, etc.). Military types require MIL-spec designation of resistance:

For 1% or smaller Tolerance

6193 = 619,000

1st significant figure — number of zeroes
2nd significant figure
3rd significant figure

For 2% or larger Tolerance

624 = 620,000

1st significant figure — number of zeroes
2nd significant figure

When the value of resistance is less than 100 ohms, or when fractional values of an ohm are required, the letter "R" is substituted for one of the significant digits to represent the decimal point, and succeeding digits of the group then represent significant figures (i.e.: 47R6 = 47.6 ohms; R50 = 0.50 ohms).

STANDARD RESISTANCE VALUES

For each size of resistor in each resistor Series in this catalog, a resistance range is given in the Characteristics and Nomenclature Table for the Series. In some cases, more than one range is listed, corresponding to the various temperature coefficients and/or resistance tolerances available in a given resistor size. The listed range in each case determines the limits within which standard resistance values are obtainable. *Within those limits,* standard values may be selected in accordance with the following table, and the specified resistance tolerance.

For a particular tolerance, any resistance value in the appropriate column may be specified, or any decade multiple (or submultiple) of that value, within the stated range. Non-standard resistance values are available on special order.

STANDARD RESISTANCE VALUES FOR THE 10-TO-100 DECADE
(also usable in decade multiples or sub-multiples)
RESISTANCE TOLERANCE (±%)

0.1% 0.25% 0.5%	1%	2% 5% 10%	0.1% 0.25% 0.5%	1%	2% 5% 10%	0.1% 0.25% 0.5%	1%	2% 5% 10%	0.1% 0.25% 0.5%	1%	2% 5% 10%	0.1% 0.25% 0.5%	1%	2% 5% 10%	0.1% 0.25% 0.5%	1%	2% 5% 10%
10.0	10.0	10	14.7	14.7	–	21.5	21.5	–	31.6	31.6	–	46.4	46.4	–	68.1	68.1	68
10.1	–	–	14.9	–	–	21.8	–	–	32.0	–	–	47.0	–	47	69.0	–	–
10.2	10.2	–	15.0	15.0	15	22.1	22.1	22	32.4	32.4	–	47.5	47.5	–	69.8	69.8	–
10.4	–	–	15.2	–	–	22.3	–	–	32.8	–	–	48.1	–	–	70.6	–	–
10.5	10.5	–	15.4	15.4	–	22.6	22.6	–	33.2	33.2	33	48.7	48.7	–	71.5	71.5	–
10.6	–	–	15.6	–	–	22.9	–	–	33.6	–	–	49.3	–	–	72.3	–	–
10.7	10.7	–	15.8	15.8	–	23.2	23.2	–	34.0	34.0	–	49.9	49.9	–	73.2	73.2	–
10.9	–	–	16.0	–	16	23.4	–	–	34.4	–	–	50.5	–	–	74.1	–	–
11.0	11.0	11	16.2	16.2	–	23.7	23.7	–	34.8	34.8	–	51.1	51.1	51	75.0	75.0	75
11.1	–	–	16.4	–	–	24.0	–	24	35.2	–	–	51.7	–	–	75.9	–	–
11.3	11.3	–	16.5	16.5	–	24.3	24.3	–	35.7	35.7	–	52.3	52.3	–	76.8	76.8	–
11.4	–	–	16.7	–	–	24.6	–	–	36.1	–	36	53.0	–	–	77.7	–	–
11.5	11.5	–	16.9	16.9	–	24.9	24.9	–	36.5	36.5	–	53.6	53.6	–	78.7	78.7	–
11.7	–	–	17.2	–	–	25.2	–	–	37.0	–	–	54.2	–	–	79.6	–	–
11.8	11.8	–	17.4	17.4	–	25.5	25.5	–	37.4	37.4	–	54.9	54.9	–	80.6	80.6	–
12.0	–	12	17.6	–	–	25.8	–	–	37.9	–	–	55.6	–	–	81.6	–	–
12.1	12.1	–	17.8	17.8	–	26.1	26.1	–	38.3	38.3	–	56.2	56.2	56	82.5	82.5	82
12.3	–	–	18.0	–	18	26.4	–	–	38.8	–	–	56.9	–	–	83.5	–	–
12.4	12.4	–	18.2	18.2	–	26.7	26.7	–	39.2	39.2	39	57.6	57.6	–	84.5	84.5	–
12.6	–	–	18.4	–	–	27.1	–	27	39.7	–	–	58.3	–	–	85.6	–	–
12.7	12.7	–	18.7	18.7	–	27.4	27.4	–	40.2	40.2	–	59.0	59.0	–	86.6	86.6	–
12.9	–	–	18.9	–	–	27.7	–	–	40.7	–	–	59.7	–	–	87.6	–	–
13.0	13.0	13	19.1	19.1	–	28.0	28.0	–	41.2	41.2	–	60.4	60.4	–	88.7	88.7	–
13.2	–	–	19.3	–	–	28.4	–	–	41.7	–	–	61.2	–	–	89.8	–	–
13.3	13.3	–	19.6	19.6	–	28.7	28.7	–	42.2	42.2	–	61.9	61.9	62	90.9	90.9	91
13.5	–	–	19.8	–	–	29.1	–	–	42.7	–	–	62.6	–	–	92.0	–	–
13.7	13.7	–	20.0	20.0	20	29.4	29.4	–	43.2	43.2	43	63.4	63.4	–	93.1	93.1	–
13.8	–	–	20.3	–	–	29.8	–	–	43.7	–	–	64.2	–	–	94.2	–	–
14.0	14.0	–	20.5	20.5	–	30.1	30.1	30	44.2	44.2	–	64.9	64.9	–	95.3	95.3	–
14.2	–	–	20.8	–	–	30.5	–	–	44.8	–	–	65.7	–	–	96.5	–	–
14.3	14.3	–	21.0	21.0	–	30.9	30.9	–	45.3	45.3	–	66.5	66.5	–	97.6	97.6	–
14.5	–	–	21.3	–	–	31.2	–	–	45.9	–	–	67.3	–	–	98.8	–	–

QUICK REFERENCE INDEX

SEALED CERMET TRIMMERS							
DESCRIPTION		SERIES	TURNS	RESISTANCE RANGE	POWER RATING (°C)	OPERATING TEMPERATURE (°C)	PAGE
SINGLETURN	3/16" RD.	RJ4	1	10-2 MEG	.50W @ 70°	−55 TO +125	547
	1/4" RD.	8014	1	10-5 MEG	.50W @ 70°	−25 TO +125	535
	1/4" RD.	RJ6	1	10-5 MEG	.50W @ 70°	−55 TO +125	548
	1/2" RD.	RJ13	1	10-5 MEG	.75W @ 70°	−55 TO +125	549
	1/4" SQ.	CT6	1	10-5 MEG	.50W @ 70°	−55 TO +125	545
	3/8" SQ.	8038	1	10-5 MEG	.50W @ 85°	−25 TO +125	541
MULTITURN	5/16" RD.	TM7	3	50-2 MEG	.50W @ 70°	−55 TO +125	554
	1/4" SQ.	8026	12	10-5 MEG	.25W @ 85°	−65 TO +150	539
	3/8" SQ.	8024	25	10-5 MEG	1.0 W @ 70°	−65 TO +150	537
	3/8" SQ.	CT9	18	10-5 MEG	.50W @ 70°	−55 TO +125	552
	3/4" REC.	CT20	15	10-2 MEG	.75W @ 70°	−55 TO +125	552

SEALED CERMET TRIMMERS							
DESCRIPTION		SERIES	TURNS	RESISTANCE RANGE	POWER RATING (°C)	OPERATING TEMPERATURE (°C)	PAGE
MILITARY:							
MIL R 22097	3/8" SQ.	RJ24	25	10-5 MEG	.50W @ 85°	−65 TO +150	537
	1/4" SQ.	RJ26	12	10-5 MEG	.25W @ 85°	−65 TO +150	539
MIL R 39035	3/8" SQ.	RJR24	25	10-5 MEG	.50W @ 85°	−65 TO +150	537
	1/4" SQ.	RJR26	12	10-5 MEG	.25W @ 85°	−65 TO +150	539
CONSUMER GRADE TRIMMERS							
DESCRIPTION		SERIES	TURNS	RESISTANCE RANGE			
CARBON							
OPEN	10MM SQ.	410	1	47-4.7M			557
ENCLOSED	10MM SQ.	483	1	100-4.7M			561
CERMET							
OPEN	10MM SQ.	482	1	100-10MEG			565
ENCLOSED	10MM SQ.	484	1	47-10MEG			567

Mepcopal Company is a joint venture of Philips Components Discrete Products Division and Copal Electronics Ltd.

Philips Components is the sales agent for all Mepcopal Products.

Mepcopal Company offers:

- SURFACE MOUNT CERMET TRIMMERS, See the Philips Components Surface Mount Device catalog for details.
- WIREWOUND TRIMMERS
- BINARY CODED DIP ROTARY SWITCHES
- PRECISION WIREWOUND POTENTIOMETERS
- TURNS COUNTING DIALS
- HIGH RELIABILITY FUSES
- MODULAR CONTROL POTENTIOMETERS

Contact the Mepcopal factory of your local Philips Components sales office or representative for details on these products.

PART NUMBERING SYSTEM

HOW TO SPECIFY INDUSTRIAL CERMET TRIMMERS

PHILIPS COMPONENTS TRADEMARK

8014	E	K	W	103
Model	E=Industrial	Tolerance K=+/−10%	Pin Style	Resistance Code

COPAL TRADEMARK

CT-6	P	103
Model	Pin Style	Resistance Code

HOW TO SPECIFY MILITARY CERMET TRIMMERS

MIL-R 39035	RJR24	F	X	103	R
	MIL Type	MIL Characteristic C=250 ppm/°C F=100 ppm/°C	Pin Style	Resistance Code	Failure Rate Level M=1%/1000 hours P=0.1%/1000 hours R=0.01%/1000 hours

MIL-R 22097	RJ24	F	X	103
	MIL Type	MIL Characteristic C=250 ppm/°C F=100 ppm/°C	Pin Style	Resistance Code

Mepcopal military trimmers are qualified to Failure Rate Level "R" and MIL Characteristic "F" for all ohmic values.

SERIES 8014

Single Turn 1/4" Round Diameter Miniature Cermet Trimmers

DESCRIPTION

Series 8014 single turn cermet trimmer is the smallest size trimmer of its type available today. The 1/4" diameter 8014 has a maximum height of .180. Specifications include a maximum contact resistance variation (CRV) of 3% maximum and less than 0.25% average.

The Series 8014 represents a major breakthrough in the design of high performance, high reliability potentiometers combining an exceptionally low profile with equally low prices.

DESIGN FEATURES

- **Low Cost**
- **Sealed** – withstands automated soldering and Industrial cleaning processes.
- **Broad Resistance Range available** – 10 Ohms to 5 Megohms.
- **Tolerance** – 10%
- **Temperature Coefficient of Resistance** – ±100PPM/°C over entire operating range.
- **CRV** – typically less than 0.25% average and 3% maximum.
- **Cermet Element** – inherent environmental stability.
- **Infinite Resolution** – For smooth, continuous adjustment of voltage or resistance . . . Even in lowest resistance designs.

RESISTANCE VALUES AND CODES

STANDARD

Ohms	Code	Ohms	Code
100	101	25K	253
200	201	50K	503
500	501	100K	104
1K	102	200K	204
2K	202	250K	254
5K	502	500K	504
10K	103	1 Meg	105
20K	203		

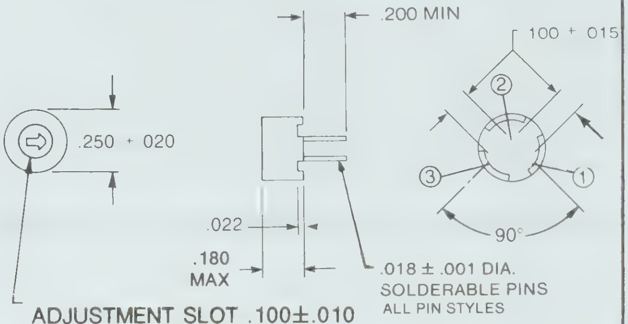
SPECIAL

Ohms	Code	Ohms	Code
10	100	2 Meg	205
20	200	5 Meg	505
50	500		

SERIES 8014
Miniature Cermet Trimmers

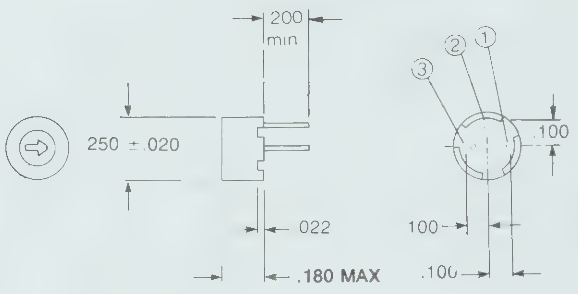
DIMENSIONS

8014EKW



ADJUSTMENT SLOT .100±.010 LONG, .030±.005 WIDE, .030±.005 DEEP, ALL PIN STYLES

8014EKP



SPECIFICATIONS

ELECTRICAL

Resistance Range:
100 ohms to 1 megohm, standard.
10, 20, 50 ohms, 2, 5 megohms, special.

Resistance Tolerance: ±10%
Temperature Coefficient: ±100 ppm/°C
Power Rating: .5 watt at 25°C derated linearly to 0 watt at 125°C.
Operating Voltage: 200 V maximum.
Slider Current: 100 mA, or within power rating, whichever is less.
End Resistance: 2 ohms, maximum.
Contact Resistance Variation: 3 ohms or 3% TR, whichever is greater.
Adjustability: ±0.03% voltage ratio; ±0.1% resistance.
Resolution: Essentially infinite.
Insulation Resistance: 1000 megohms minimum.
Dielectric Strength: 600 VAC minimum.
Operating Range: −25°C to +125°C.
Electrical Angle: 190° nominal.

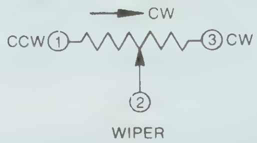
MECHANICAL

Element: Cermet
Seal: Sealed to allow wave soldering and immersion cleaning.
Adjustment: 240° nominal.
Operating Torque: 3 oz-in maximum.
Stops: Solid both ends.
Rotational Life: 200 cycles.
Terminals: .018" dia. solderable pins.
Terminal Strength: 2 lbs. min., four 90° bends.
Weight: .30 g (.011 oz.) maximum.
Housing & Rotor: Thermoplastic.
Marking: resistance value.

ENVIRONMENTAL

Will perform satisfactorily under the following test conditions:
Thermal Shock: −25°C to +125°C.
Shock: 100G
Vibration: 20 G, 10 Hz to 2000 Hz.
Moisture: 10 days, 80-98% RH
Life: .5 watt at 25°C for 1000 hours
Resistance to Soldering Heat: 350°C for 3 seconds.

SCHEMATIC



- TOLERANCES NOT SPECIFIED ARE ±.010
- NOTE: W PIN SPACING FITS JEDEC TO-18 PATTERN.
  P PIN SPACING FITS JEDEC TO-5 PATTERN.

7
Cermet Trimmers

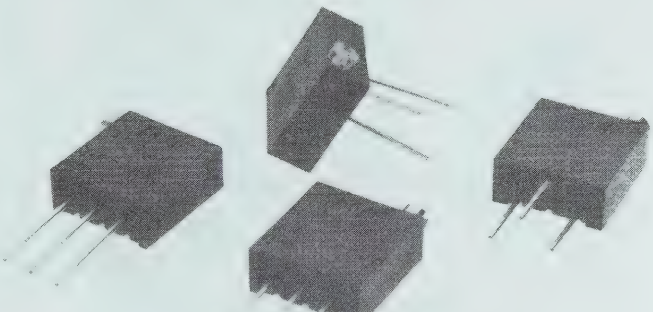
SERIES 8024 RJ24/RJR24

Multiturn Cermet Trimmers 3/8" Square

DESCRIPTION

Series 8024 (Industrial), RJ24 (MIL) and RJR24 (MIL-Established Reliability) trimmers consist of a ceramic/metal resistance element deposited on a ceramic substrate that is sealed against moisture and contaminants in a rugged housing designed to withstand high levels of vibration and shock. End-to-end resistance values range from 10 ohms to 5 megohms, with very low T.C. over a wide temperature span.

Continuous cermet film provides infinite resolution. Performance, both AC and high frequency, meets MIL-R-22097 and MIL-R-39035. Electromechanical and time/temperature stabilities are excellent. Series provides worry free performance.



DESIGN FEATURES

- **Essentially Infinite Resolution**—for smooth, continuous adjustment of voltage or resistance ...even in lowest-resistance designs.
- **Excellent Electromechanical Stability**—initial adjustment is maintained even under severe shock and/or continuous vibration.
- **Very High Temperature/Time Stability**—T.C. and long-term-drift characteristics approach those of wirewound controls costing far more and providing much less resolution.
- **Full MIL Conformance**—Plus generous safety margins.

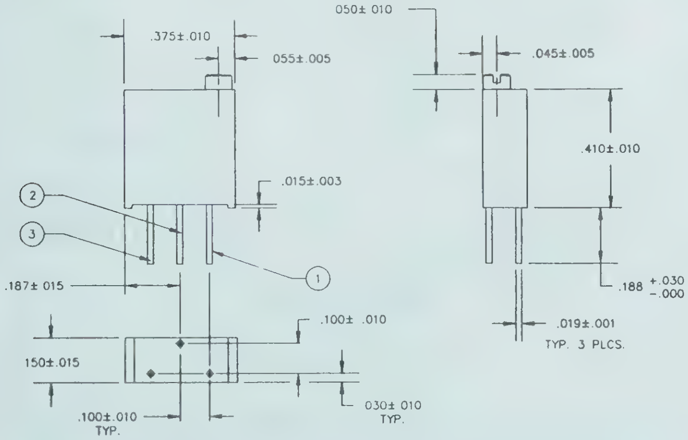
RESISTANCE VALUES AND CODES

Ohms	Code	Ohms	Code
STANDARD			
100	101	25K	253
200	201	50K	503
500	501	100K	104
1K	102	200K*	204
2K	202	250K	254
5K	502	500K	504
10K	103	1 Meg	105
20K	203		
SPECIAL			
10	100	2 Meg*	205
20	200	5 Meg*	505
50	500		

*Not standard for RJ models

DIMENSIONS

Industrial
8024 EKY



2. SHAFT HEAD .090±.005 DIA. WITH .020±.005 W x .025±.005 DP. SLOT.

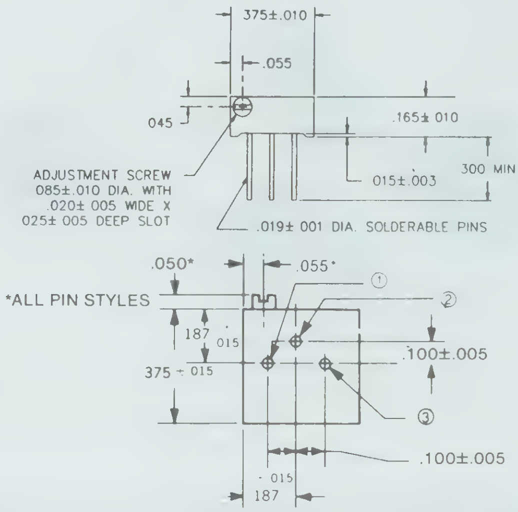
1. ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED

SERIES 8024 RJ24/RJR24

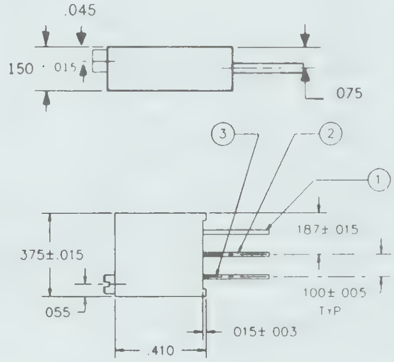
Multiturn Cermet Trimmers

DIMENSIONS

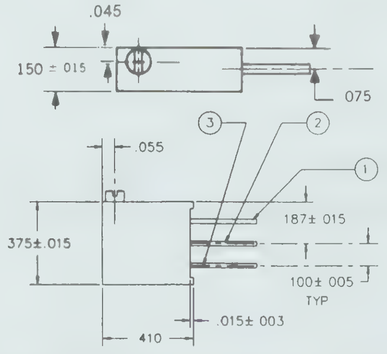
INDUSTRIAL	MIL-R-22097	MIL-R-39035
8024EKP	RJ24FP	RJR24FP



INDUSTRIAL	MIL-R-22097	MIL-R-39035
8024EKW	RJ24FW	RJR24FW



INDUSTRIAL	MIL-R-22097	MIL-R-39035
8024EKX	RJ24FX	RJR24FX



■ TOLERANCES NOT SPECIFIED ARE ±.010

SPECIFICATIONS

ELECTRICAL

Resistance Range:
100 ohms to 1 megohm, standard.
10, 20, 50 ohms, 2, 5 megohms, special.
Resistance Tolerance: ±10%
Temperature Coefficient: ±100 ppm/°C;

Power Rating: 1 watt at 70°C, industrial; .5 watt at 85°C derated linearly to 0 watt at 150°C, military.
Operating Voltage: 300 V maximum.
Slider Current: 100 mA, or within power rating, whichever is less.
End Resistance: 2 ohms, maximum.
Contact Resistance Variation: 3 ohms or 3% TR, whichever is greater.
Adjustability: ±0.03% voltage ratio; ±0.1% resistance.
Resolution: Essentially infinite.
Insulation Resistance: 1000 megohms minimum.
Dielectric Strength: 900 VAC minimum.
Operating Range: –65°C to +150°C.

MECHANICAL

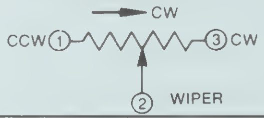
Element: Cermet
Seal: Sealed to allow wave soldering and immersion cleaning.
Adjustment: 25 turns nominal.
Operating Torque: 5 oz-in maximum.
Stops: Clutch action both ends.
Rotational Life: 200 cycles (△T.R.≤2%).
Terminals: .019" dia. solderable pins.
Terminal Strength: 2 lbs. min., four 90° bends.
Weight: .90 g (.031 oz.) maximum.
Housing: Thermoplastic
Marking: logo, part number, pin numbers, schematic, pin style, resistance code, date code.

ENVIRONMENTAL – Per MIL-R-22097/MIL-R-39035

Characteristic	"F"
Temp. Coeff. PPM/°C	±100
Maximum % change in total resistance:	
Thermal shock –65°C to + 150°C	1%
Moisture, 10 days, 80-98% R.H.	1%
Shock, 100G	1%
Vibration, 20G to 2kHz	1%
Life. 0.5W @ +85°C	
RJ - 1000 hours	2%
RJR - 10000 hours	5%
Low Temp. exposure –55°C	1%
High Temp. exposure @ 150°C	
RJ - 250 hours	2%
RJR - 1000 hours	2%
Rotational life, 200 cycles	2%
Immersion, water, no leaks	85°C
Solderability	95% coverage
Salt spray, 96 hours	Resistant
Dielectric strength	350VAC at 70,000 ft.
Operating Range	–65°C to +150°C

NOTE: Industrial models designed to meet Mil-R-22097 Characteristic "F".

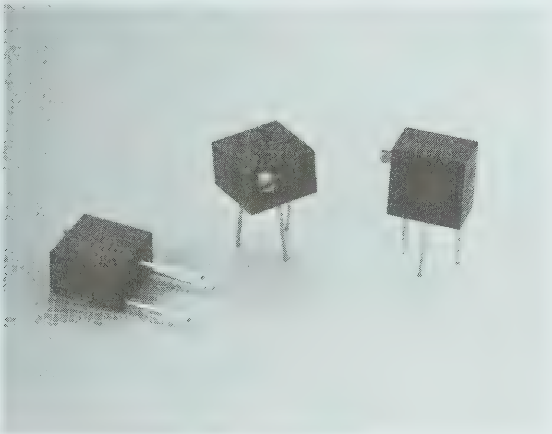
SCHEMATIC



Mepcopal Company • 11468 Sorrento Valley Road • San Diego, CA 92121 • (619) 453-0332 • FAX: (619) 481-1123

SERIES 8026/RJ26/RJR26

Multiturn Cermet Trimmers 1/4" Square



DESCRIPTION

Series 8026 (Industrial), RJ26 (MIL) and RJR26 (MIL-Established Reliability) consist of a ceramic/metal resistance element on a ceramic substrate that is sealed against moisture and other contaminants in a rugged enclosure designed to withstand high levels of shock and vibration. End-to-end resistance values range from 10 ohms to 5 megohms with very low temperature coefficient.

Continuous cermet film provides infinite resolution. With 12 adjustment turns, setability is excellent. Performance, both AC and high frequency, meets MIL-R-22097 and MIL-R-39035. End resistance is negligible, and electromechanical and time/temperature stabilities are excellent. This series provides the highest reliability and performance in 0.25-Watt applications where multiturn setability in the smallest possible space is required.

RESISTANCE VALUES AND CODES

STANDARD

Ohms	Code	Ohms	Code
100	101	25K	253
200	201	50K	503
500	501	100K	104
1K	102	200K*	204
2K	202	250K	254
5K	502	500K	504
10K	103	1 Meg	105
20K	203		

SPECIAL

Ohms	Code	Ohms	Code
10	100	2 Meg*	205
20	200	5 Meg*	505
50	500		

*Not standard for RJ models

DESIGN FEATURES

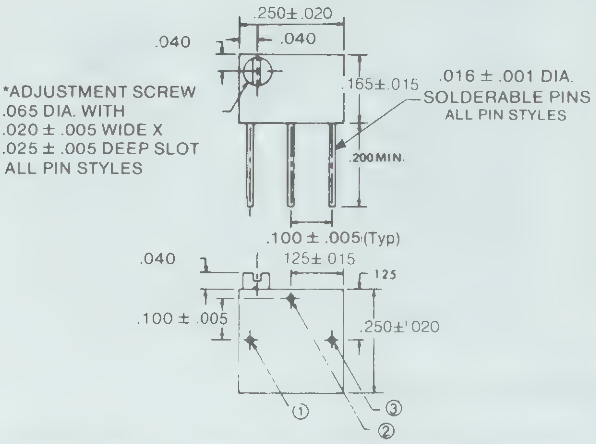
- **Wide Design Freedom** — all three orientations of mounting and adjustment access.
- **Full MIL Conformance** – Plus Generous Safety Margins.
- **Essentially Infinite Resolution** — for smooth, continuous adjustment of voltage or resistance... even in lowest-resistance designs.
- **Excellent Electromechanical Stability** — Initial adjustment is maintained even under severe shock and/or continuous vibration.
- **Very High Temperature/Time Stability** — T.C. and long-term-drift characteristics approach those of wirewound controls costing far more and providing much less resolution.
- **Very Low End Resistance** — minimum resistance at either end of range is essentially negligible, except in lowest-resistance units.
- **Wide Range of Resistances**

SERIES 8026 RJ26/RJR26

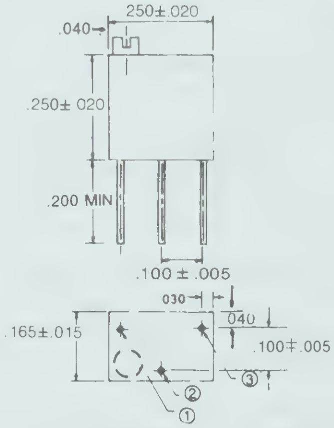
Multiturn Cermet Trimmers

DIMENSIONS

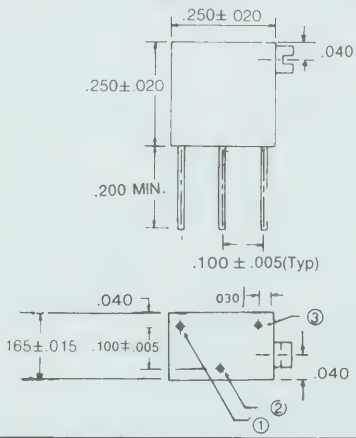
INDUSTRIAL	MIL-R-22097	MIL-R-39035
8026EKP	RJ26FP	RJR26FP



INDUSTRIAL	MIL-R-22097	MIL-R-39035
8026EKW	RJ26FW	RJR26FW



INDUSTRIAL	MIL-R-22097	MIL-R-39035
8026EKX	RJ26FX	RJR26FX



■ TOLERANCES NOT SPECIFIED ARE ±.010

SPECIFICATIONS

ELECTRICAL

Resistance Range:
100 ohms to 1 megohm, standard.
10, 20, 50 ohms, 2, 5 megohms, special.
Resistance Tolerance: ±10%
Temperature Coefficient: ±100 ppm/°C
Power Rating: .25 watt at 85°C derated linearly to 0 watt at 150°C.
Operating Voltage: 200 V maximum.
Slider Current: 100 mA, or within power rating, whichever is less.
End Resistance: 2 ohms maximum.
Contact Resistance Variation: 3 ohms or 3% TR, whichever is greater.
Adjustability: ±0.03% voltage ratio; ±0.1% resistance.
Resolution: Essentially infinite.
Insulation Resistance: 1000 megohms minimum.
Dielectric Strength: 600 VAC minimum.
Operating Range: −65°C to +150°C.

MECHANICAL

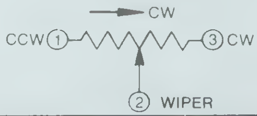
Element: Cermet
Seal: Sealed to allow wave soldering and immersion cleaning.
Adjustment: 12 turns nominal.
Operating Torque: 3 oz-in maximum.
Stops: Clutching action both ends.
Rotational Life: 200 cycles (ΔT.R. ≤ 2%).
Terminals: .016 dia. solderable pins.
Terminal Strength: 2 lbs. min., four 90° bends.
Weight: .44 g (.015 oz) maximum.
Housing: Thermoplastic.
Marking: part number, pin numbers, schematic, pin styl, resistance code date code.

ENVIRONMENTAL – Per MIL-R-22097/MIL-R-39035

Characteristic	"F"
Temp. Coeff. PPM/°C	±100
Maximum % change in total resistance:	
Thermal shock −65°C to + 150°C	1%
Moisture, 10 days, 80-98% R.H.	1%
Shock, 100G	1%
Vibration, 20G to 2kHz	1%
Life, 0.5W @ +85°C	
RJ - 1000 hours	2%
RJR - 10000 hours	5%
Low Temp. exposure −55°C	1%
High Temp. exposure @ 150°C	
RJ - 250 hours	2%
RJR - 1000 hours	2%
Rotational life, 200 cycles	2%
Immersion, water, no leaks	85°C
Solderability	95% coverage
Salt spray, 96 hours	Resistant
Dielectric strength	350VAC at 70,000 ft.
Operating Range	−65°C to +150°C

NOTE: Industrial models designed to meet Mil-R-22097 Characteristic "F".

SCHEMATIC



7

Cermet Trimmers

Mepcopal Company • 11468 Sorrento Valley Road • San Diego, CA 92121 • (619) 453-0332 • FAX: (619) 481-1123

Single Turn Cermet Trimmers 3/8" Square

DESCRIPTION

Series 8038 single turn cermet trimmer consists of a ceramic/metal resistance element deposited on a ceramic substrate that is sealed against moisture and contaminants in a rugged thermoplastic housing.

The Series 8038 offers high performance and high reliability at an economical price.

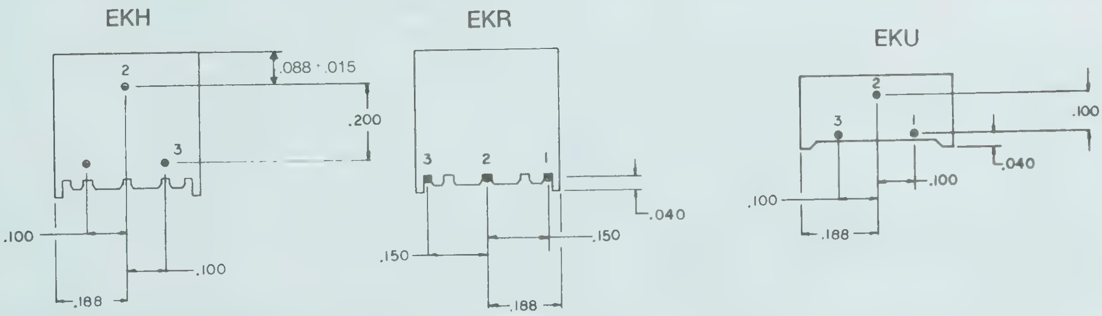
RESISTANCE VALUES AND CODES

Ohms	Code	Ohms	Code
STANDARD			
100	101	25K	253
200	201	50K	503
500	501	100K	104
1K	102	200K	204
2K	202	250K	254
5K	502	500K	504
10K	103	1 Meg	105
20K	203		
SPECIAL			
Ohms	Code	Ohms	Code
10	100	2 Meg	205
20	200	5 Meg	505
50	500		

DESIGN FEATURES

- **Low Cost**
- **Sealed** – withstands automated soldering and industrial cleaning processes.
- **Broad Resistance Range available** – 10 Ohms to 5 Megohms.
- **Tolerance** – 10% Standard.
- **Temperature Coefficient of Resistance** – ±100PPM/°C over entire operating range.
- **CRV** – typically less than 0.25% average and 3% maximum.
- **Cermet Element** – inherent environmental stability.
- **Infinite Resolution** – For smooth, continuous adjustment of voltage or resistance . . . Even in lowest resistance designs.

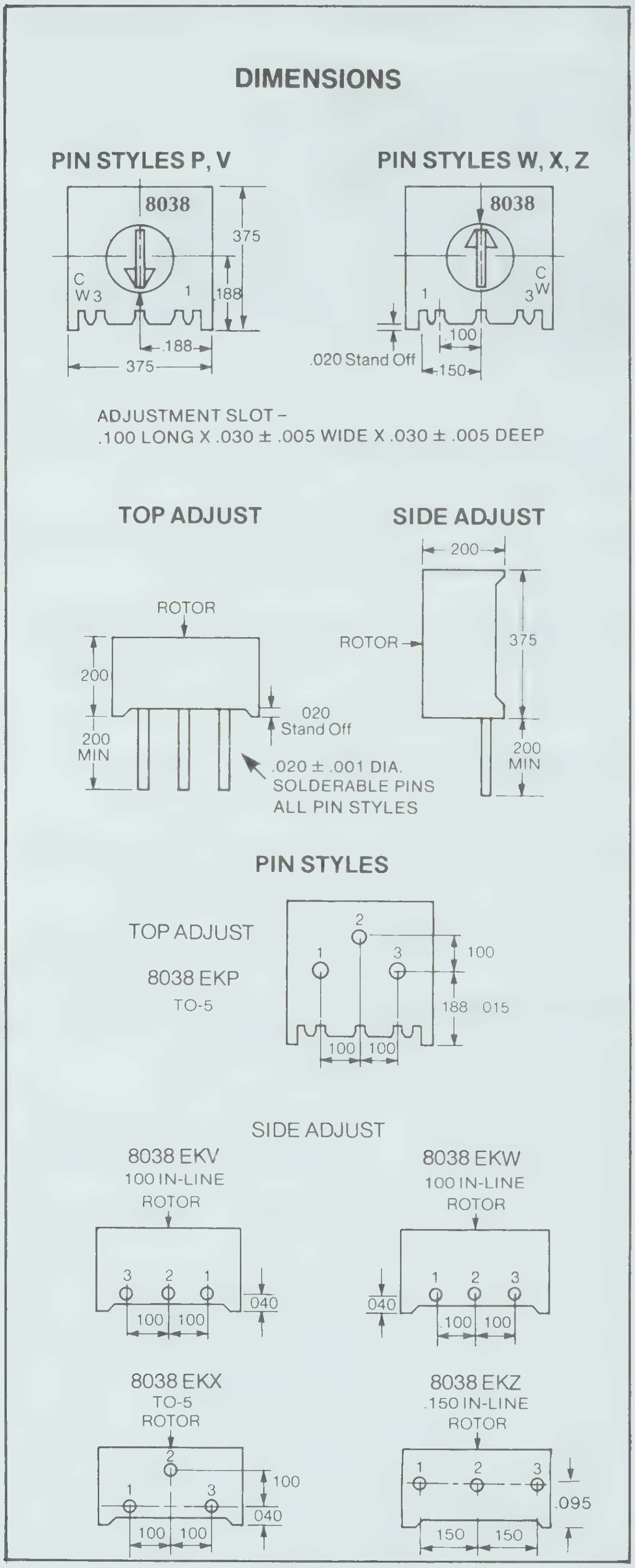
SPECIAL PIN STYLES 8038 EKH, EKR, EKU



Contact factory for price and delivery.

SERIES 8038

Single Turn Cermet Trimmers



SPECIFICATIONS

ELECTRICAL

Resistance Range:
100 ohms to 1 megohm, standard.
10, 20, 50 ohms, 2, 5 megohms, special.
Resistance Tolerance: ±10%
Temperature Coefficient: ±100 ppm/°C
Power Rating: .5 watt at 85°C derated linearly to 0 watt at 125°C.
Operating Voltage: 300 V maximum.
Slider Current: 100 mA, or within power rating, whichever is less.
End Resistance: 2 ohms, maximum
Contact Resistance Variation: 3 ohms or 3% TR, whichever is greater.
Adjustability: ±0.03% voltage ratio; ±0.10% resistance.
Resolution: Essentially infinite.
Insulation Resistance: 1000 megohms minimum.
Dielectric Strength: 900 VAC minimum.
Operating Range: –25°C to +125°C.
Electrical Angle: 270° nominal.

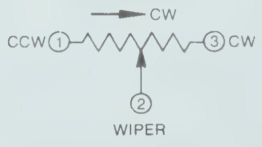
MECHANICAL

Element: Cermet
Seal: Sealed to allow wave soldering and immersion cleaning.
Adjustment: 300° nominal.
Operating Torque: 3 oz-in maximum.
Stops: Solid both ends.
Rotational Life: 200 cycles.
Terminals: .020" dia. solderable pins.
Terminal Strength: 2 lbs. min., four 90° bends.
Weight: 1.13 g (.04 oz.) maximum.
Housing & Rotor: Thermoplastic
Marking: part number, pin numbers, CW pin, rotor indicator, resistance code, date code and pin style.

ENVIRONMENTAL

Will perform satisfactorily under the following test conditions:
Thermal Shock: −25°C to +125°C.
Shock: 100 G
Vibration: 20 G, 10 Hz to 2000 Hz
Moisture: 10 days, 80-98% RH
Life: .5 watt at 85°C for 1000 hours.
Resistance to Soldering Heat: 350°C for 3 seconds.

SCHEMATIC



■ TOLERANCES NOT SPECIFIED ARE ±.010

7 Cermet Trimmers

 Mepcopal Company • 11468 Sorrento Valley Road • San Diego, CA 92121 • (619) 453-0332 • FAX: (619) 481-1123

SERIES CT & RJ

Single Turn Cermet Trimmers

STANDARD SPECIFICATIONS

ELECTRICAL

Model No / Item	CT-6	RJ-4	RJ-6	RJ-13
Resistance range	10Ω ~ 2MΩ	10Ω ~ 2MΩ	10Ω ~ 5MΩ	
Resistance tolerance	±10%	±20%	±10%	
Power ratings	0.5W(70°C) 0W (125°C)			0.75W(70°C) 0W (125°C)
Max. input voltage	200V DC or power rating, whichever is smaller.			300V DC
Max. wiper current	100mA or power rating, whichever is smaller.			
Electrical angle, nominal	220°	200°	230°	
Electrical continuity	Continuous for full mechanical range.			
End resistance, max.	1% or 2Ω, whichever is greater.			
Resolution	Essentially infinite			
C.R.V. (MIL-R-22097), max.	1% or 3Ω, whichever is greater.			
Operating temp. range	−55°C ~ +125°C			
Temp. coefficient, max. (−55°C ~ +125°C)	50Ω ~ 2MΩ: ±100ppm/°C 10,20Ω ±250ppm/°C	100Ω ~ 2M: ±100 ppm/°C 10Ω ~ 50Ω: ±250ppm/°C	50Ω ~ 2MΩ: ±100ppm/°C 10,20,5MΩ ±250ppm/°C	
Insulation resistance, min.	1,000MΩ (DC500V)			
Dielectric strength	900 Vrms (1 minute)	500 Vrms (1 minute)	900 Vrms (1 minute)	

MECHANICAL

Model No. / Item	CT-6	RJ-4	RJ-6	RJ-13
Mechanical angle, nominal	260°	230°	270°	
Shaft torque, max.	20 ~ 200 g-cm	150 g-cm	20 ~ 150 g-cm	30 ~ 350 g-cm
Stop strength min.	500 g-cm	450 g-cm	500 g-cm	1kg-cm
Terminal strength, min.	1 kg (MIL-R-22097)			2 kg
Rotational life	200 cycles (ΔR/R≦±(2Ω+3%))	200 cycles (10Ω ~ 200Ω ΔR/R≦±(0.5Ω +3%)), (500Ω up: ΔR/R≦±(0.5Ω +2%))		
Style	P, W, R, V, S, X, H, TV, TH MP, MS	W, WS	P, W, S, X, F	P, S, B, PR, SR

ENVIRONMENTAL (MIL-R-22097)

Thermal Shock	−65°C ~ +125°C (ΔR/R≦1%) (S.S.≦1%)	
Humidity	80 ~ 98%RH, 10 cycles, 240hrs., (ΔR/R≦2%)	(ΔR/R≦1%)
Shock	100G (ΔR/R≦1%) (S.S.≦1%)	
Vibration	20G, 10 ~ 2,000Hz, (ΔR/R≦1%) (S.S.≦1%)	
Load life	70°C, Rated power, 1,000hrs. (ΔR/R≦3%) (S.S.≦1%)	(ΔR/R≦2%) (S.S.≦1%)
Low temperature operation	−55°C, 2hrs. (ΔR/R≦2%) (S.S.≦2%)	(ΔR/R≦1%) (S.S.≦2%)
High temperature exposure	125°C, 250hrs. (ΔR/R≦3%) (S.S.≦2%)	(ΔR/R≦2%) (S.S.≦2%)
Immersion seal	No leaks @ 85°C	
Soldering heat	350°C, 3 sec. (ΔR/R≦1%)	

ΔR/R: Change in total resistance S.S.: Setting stability

SERIES CT & RJ

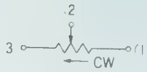
Single Turn Cermet Trimmers

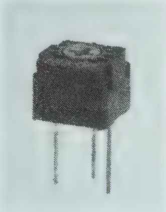
STANDARD RESISTANCE VALUES AND MAX. INPUT RATINGS

Resistance		Max, input voltage (V)				Max. wiper current (mA)			
Ohm (Ω)	Code	CT-6	RJ-4	RJ-6	RJ-13	CT-6	RJ-4	RJ-6	RJ-13
10	100	1.00				100			
20	200	2.00				100			
50	500	5.00				100			
100	101	7.07			8.66	70.7			86.6
200	201	10.0			12.2	50.0			61.0
500	501	15.8			19.4	31.6			38.8
1K	102	22.4			27.4	22.4			27.4
2K	202	31.6			38.7	15.8			19.3
5K	502	50.0			61.2	10.0			12.2
10K	103	70.7			86.6	7.07			8.66
20K	203	100			122	5.00			6.10
25K	253	/	/	112	137	/	/	4.48	5.48
50K	503	158			194	3.16			3.88
100K	104	200			274	2.00			2.74
200K	204	200			300	1.00			1.50
250K	254	/	/	200	300	/	/	0.80	1.20
500K	504	200			300	0.40			0.60
1M	105	200			300	0.20			0.30
2M	205	200			300	0.10			0.15
5M	505	/	/	200	300	/	/	0.04	0.06

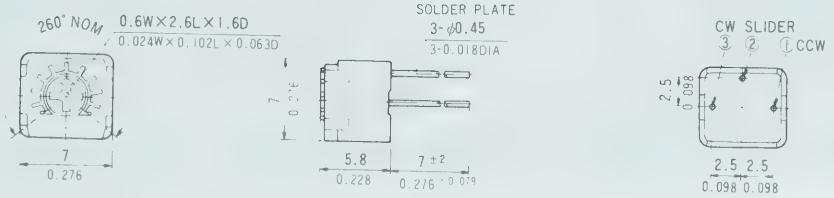
DIMENSIONS (in mm/inch)

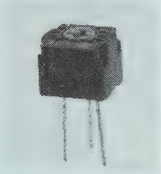
CT-6
Unspecified tolerance ±0.3 mm/±0.012 inch



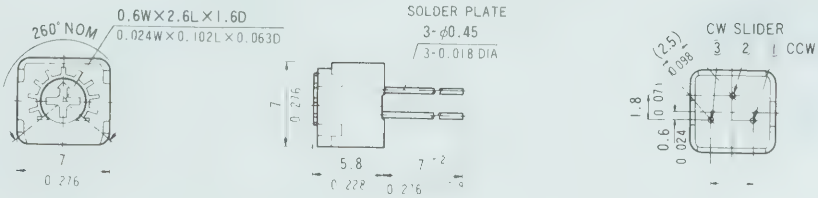


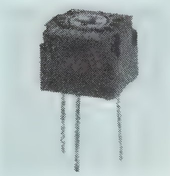
CT-6P
Top adjustment



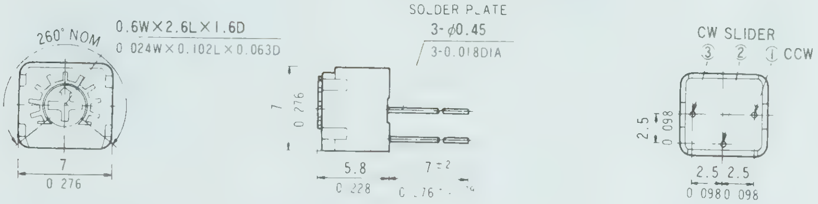


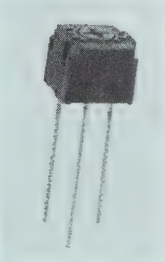
CT-6W
Top adjustment



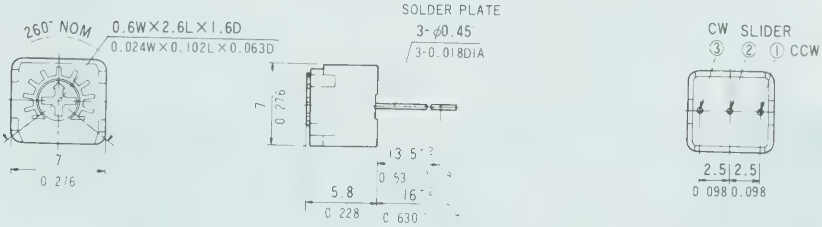


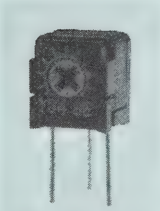
CT-6R
Top adjustment



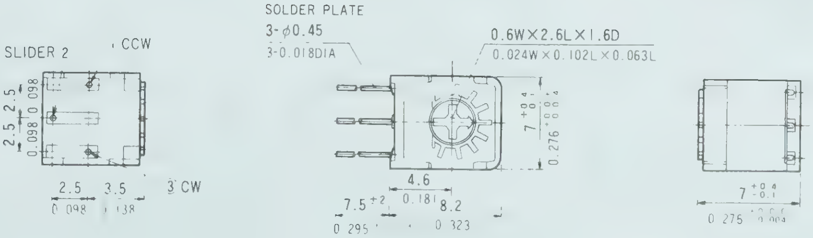


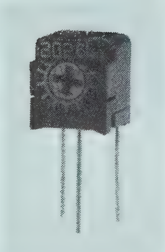
CT-6V
Top adjustment



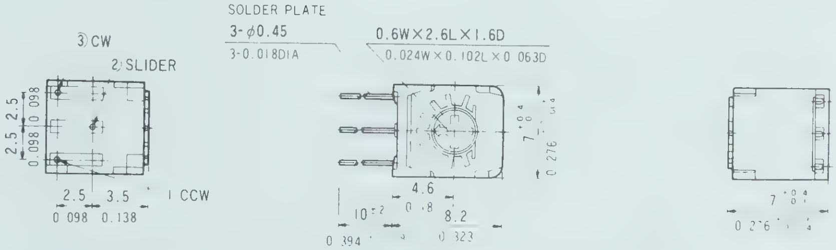


CT-6S
Side adjustment



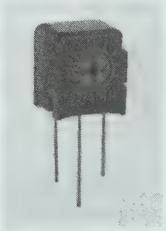


CT-6X
Side adjustment

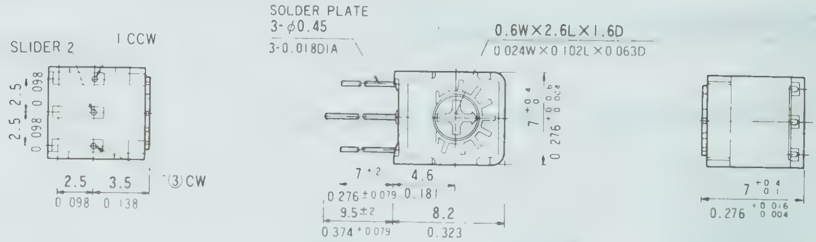


7
Cermet Trimmers

SERIES CT & RJ
Single Turn Cermet Trimmers

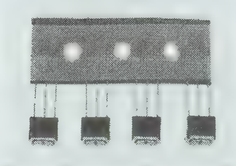


CT-6H
Side adjustment

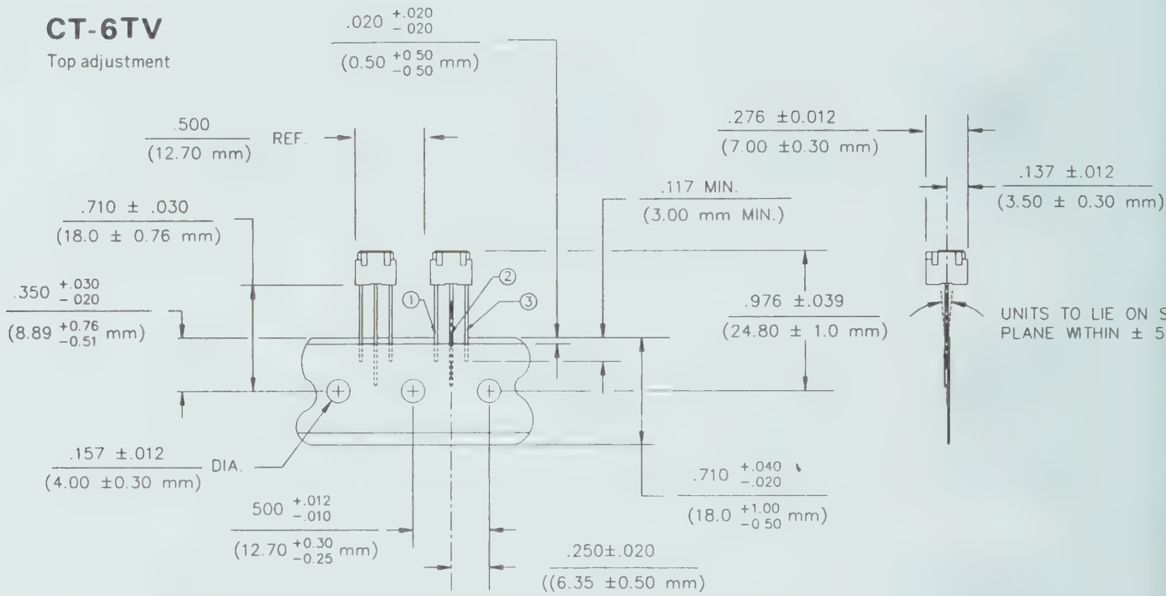


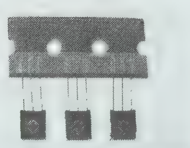
CT-6 for automatic insertion
Unspecified tolerance ±0.3 mm/±0.012 inch

Taped Version
1,000 pcs per reel

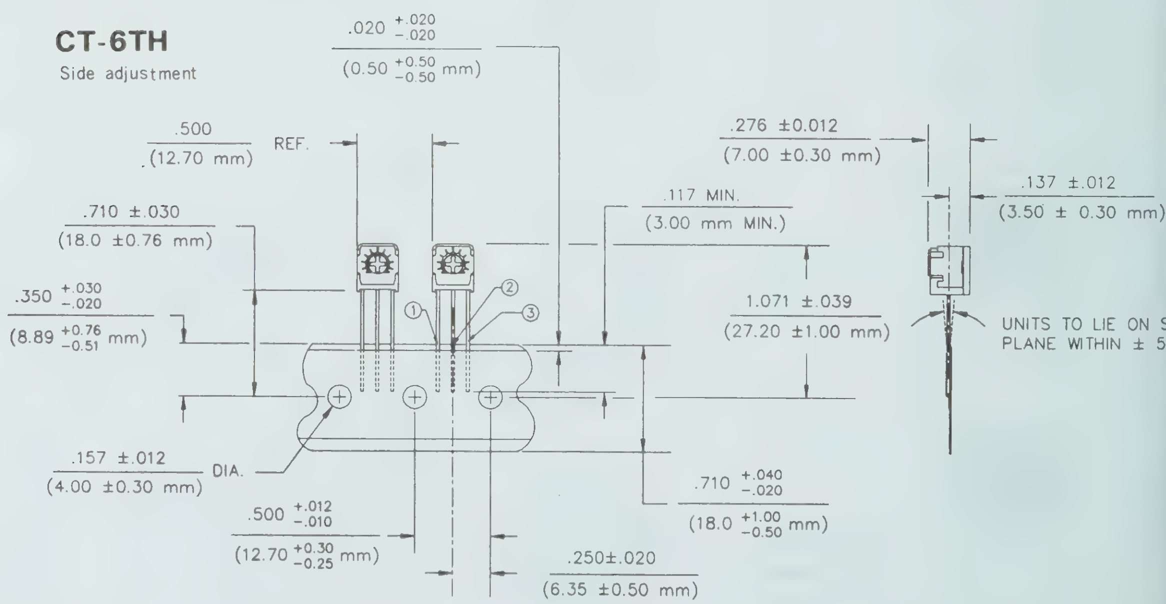


CT-6TV
Top adjustment





CT-6TH
Side adjustment



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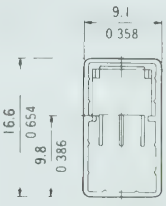
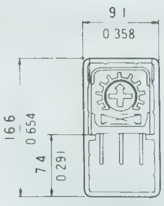
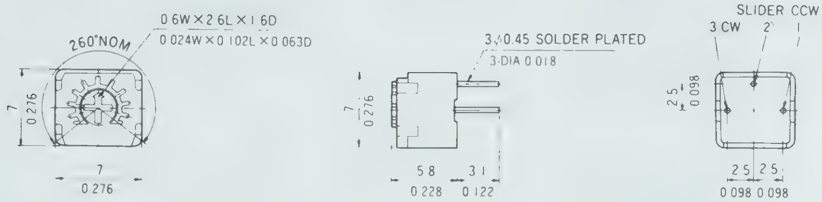
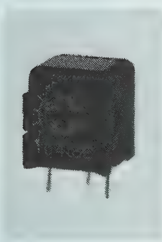
Plastic Magazine Version
75 pcs per stick



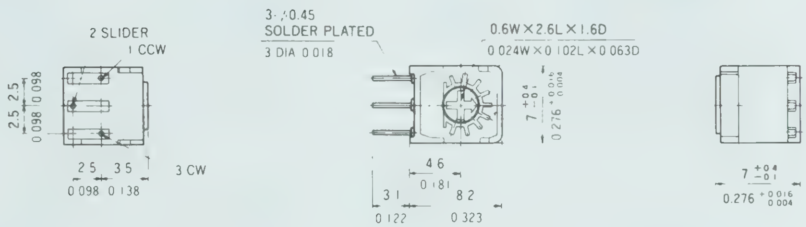


CT-6MP
Top adjustment

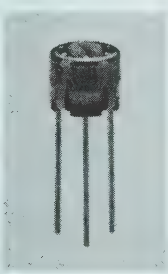




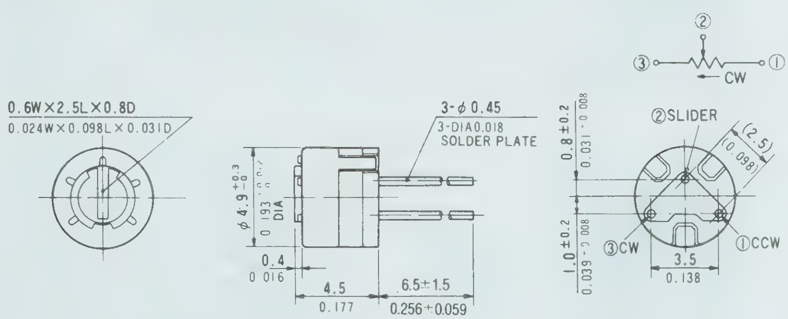
CT-6MS
Side adjustment

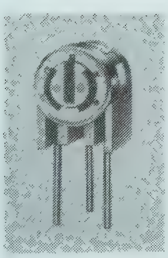


RJ-4
Unspecified tolerance ±0.3 mm/±0.012 inch

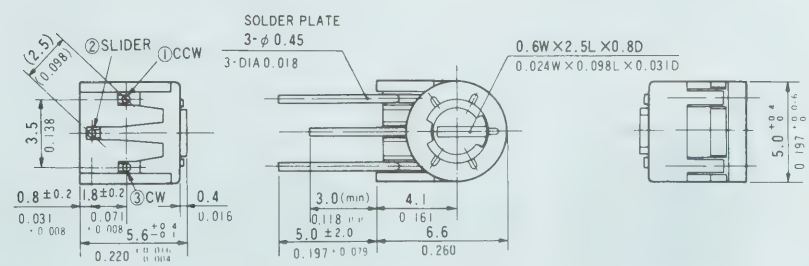


RJ-4W
Top adjustment





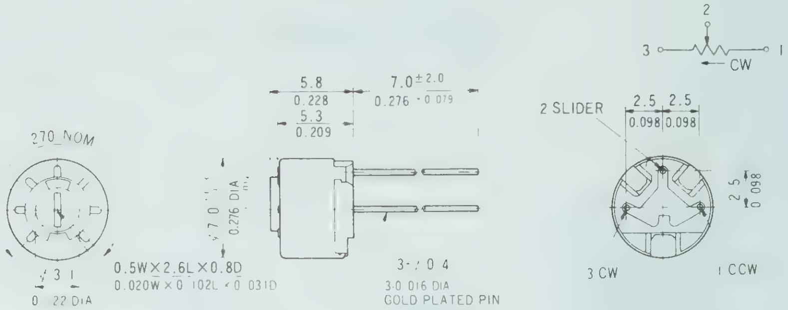
RJ-4WS
Side adjustment



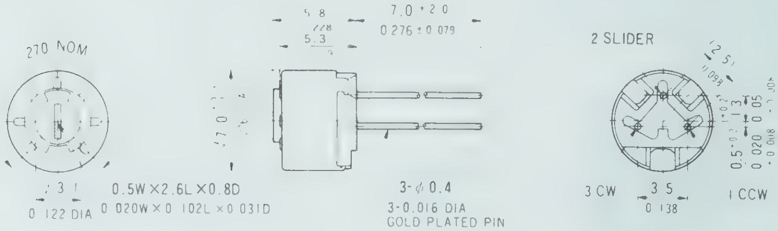
SERIES CT & RJ
Single Turn Cermet Trimmers

RJ-6
Unspecified tolerance ±0.3 mm/±0.012 inch

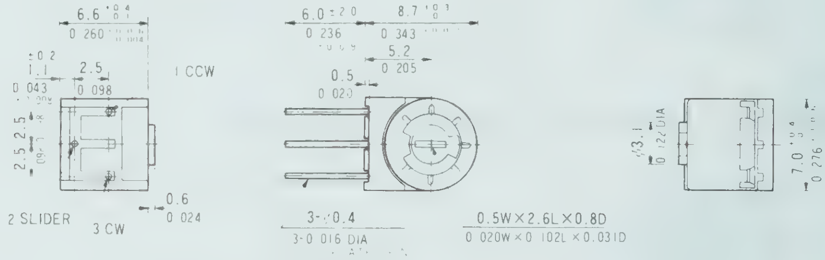
RJ-6P
Top adjustment



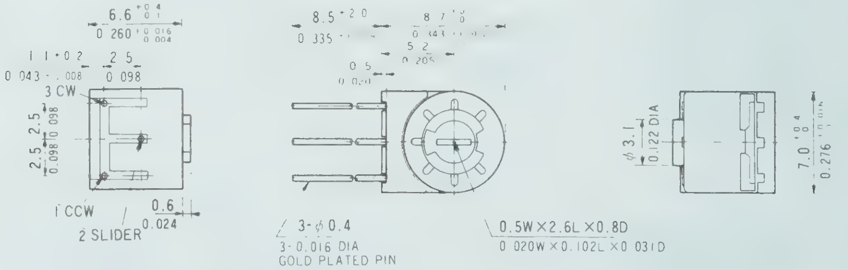
RJ-6W
Top adjustment

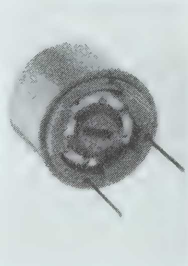


RJ-6S
Side adjustment

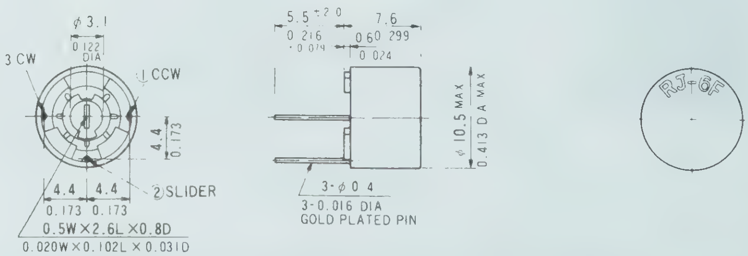


RJ-6X
Side adjustment



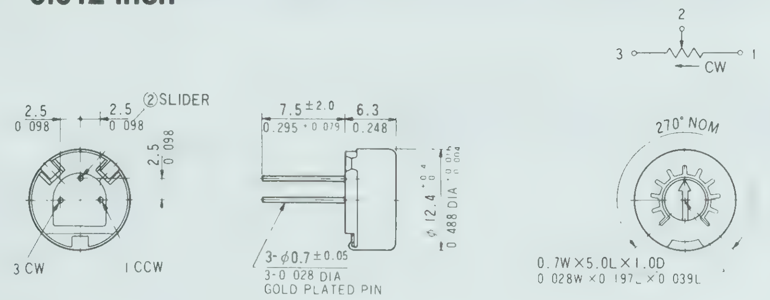


RJ-6F
Rear adjustment

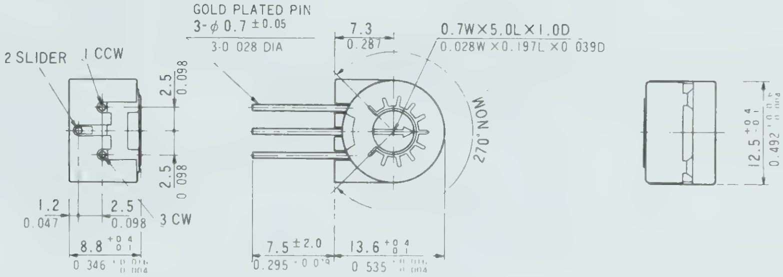


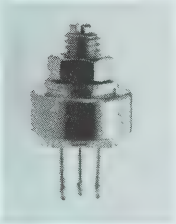
RJ-13
Unspecified tolerance ±0.3 mm/±0.012 inch

RJ-13P
Top ajustment

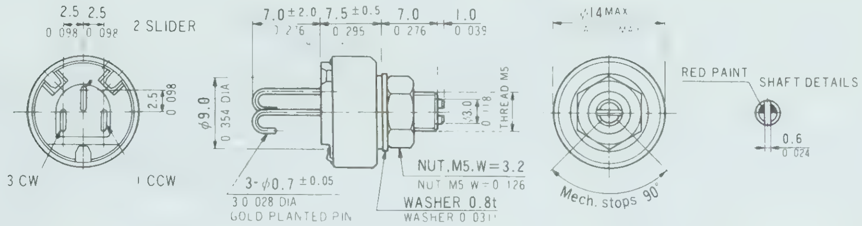


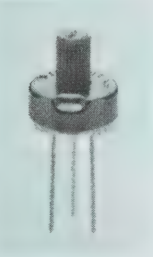
RJ-13S
Side adjustment



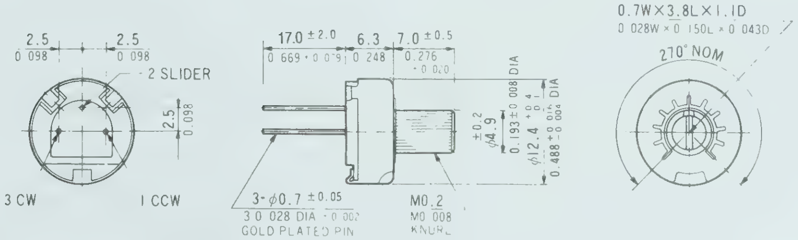


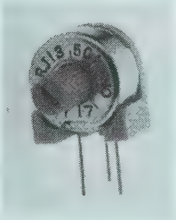
RJ-13B
Panel mount



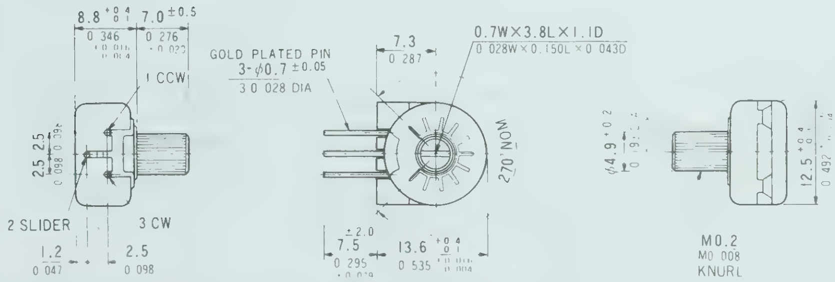


RJ-13PR
Top adjustment





RJ-13SR
Side adjustment



7

Cermet Trimmers

SERIES CT & TM

Multiturn Cermet Trimmers

STANDARD SPECIFICATIONS

ELECTRICAL

Item / Model No.	CT-20	CT-9	TM-7
Resistance range	10R	10Ω ~ 5MΩ	50Ω ~ 2MΩ
Resistance tolerance	2MR · 10%		
Power ratings	.75W (70°C)	0.5W (70°C) 0W (125°C)	
Max input voltage	300V DC or power rating, whichever is smaller.		
Max. wiper current	100mA or power rating, whichever is smaller.		
Electrical continuity	Continuous full mechanical range.		
End resistance, max.	1% or 2Ω, whichever is greater.		
Resolution	Essentially infinite		
C.R.V., max. (MIL-R-22097)	1% or 3Ω, whichever is greater.		
Operating temp. range	−55°C ~ +125°C		
Temp. coefficient, max. (−55°C ~ +125°C)	50Ω-2MΩ ±100ppm/°C 10Ω, 20Ω ±250ppm/°C	50Ω-2mΩ ±100ppm/°C 10Ω 20Ω, 5MΩ ±250ppm/°C	±100ppm/°C
Insulation Resistance, min.	1,000 MΩ (DC 500V)		
Dielectric strength	600 Vrms (1 minute)	900 Vrms (1 minute)	

MECHANICAL

Item / Model No.	CT-20	CT-9	TM-7
Mechanical adjustment	15 turns	18 turns	3 turns
Shaft torque, max.	360 g-cm		200 g-cm
Mechanical stop	Clutch action		
Terminal strength, min.	900 g	1 kg	
Rotational life	200 cycles		
	(10Ω ~ 200Ω ΔR/R ≦ (0.5Ω+3%)) (500Ω ~ 5MΩ ΔR/R ≦ (0.5Ω+2%))		(ΔR/R ≦ (2Ω+3%))
Style	P, X	P, W, X	P, W, S, X

ENVIRONMENTAL (MIL-R-22097)

Thermal shock	−65°C ~ +125°C, (ΔR/R ≦ 1%) (S.S. ≦ 1%)	
Humidity	80 ~ 98% RH, 10 cycles, 240 hrs.,	
	(ΔR/R ≦ 1%)	(ΔR/R ≦ 2%)
Shock	100G, (ΔR/R ≦ 1%) (S.S. ≦ 1%)	
Vibration	20G, 10 ~ 2,000Hz, (ΔR/R ≦ 1%) (S.S. ≦ 1%)	
Load life	70°C, Rated power, 1,000 hrs.	
	(ΔR/R ≦ 2%) (S.S. ≦ 1%)	(ΔR/R ≦ 3%) (S.S. ≦ 1%)
Low temperature operation	−55°C, 2 hrs.,	
	(ΔR/R ≦ 1%) (S.S. ≦ 2%)	(ΔR/R ≦ 2%) (S.S. ≦ 2%)
High temperature exposure	125°C, 250 hrs.,	
	(ΔR/R ≦ 2%) (S.S. ≦ 2%)	(ΔR/R ≦ 3%) (S.S. ≦ 2%)
Immersion seal	No leaks @ 85°C	
Soldering heat	350°C, 3 sec. (ΔR/R ≦ 1%)	

ΔR/R: Change in total resistance
S.S.: Setting stability

STANDARD RESISTANCE VALUES AND MAX. INPUT RATINGS

<table>
<tr><th colspan="2">Resistance</th><th colspan="3">Max, input voltage (V)</th><th colspan="3">Max. wiper current (mA)</th></tr>
<tr><th>(Ω)</th><th>Code</th><th>CT-20</th><th>CT-9</th><th>TM-7</th><th>CT-20</th><th>CT-9</th><th>TM-7</th></tr>
<tr><td>10</td><td>100</td><td colspan="2">1.00</td><td></td><td colspan="2">100</td><td></td></tr>
<tr><td>20</td><td>200</td><td colspan="2">2.00</td><td></td><td colspan="2">100</td><td></td></tr>
<tr><td>50</td><td>500</td><td colspan="3">5.00</td><td colspan="3">100</td></tr>
<tr><td>100</td><td>101</td><td>8.66</td><td colspan="2">7.07</td><td>86.6</td><td colspan="2">70.7</td></tr>
<tr><td>200</td><td>201</td><td>12.2</td><td colspan="2">10.0</td><td>61.0</td><td colspan="2">50.0</td></tr>
<tr><td>500</td><td>501</td><td>19.4</td><td colspan="2">15.8</td><td>38.8</td><td colspan="2">31.6</td></tr>
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<tr><td>5K</td><td>502</td><td>61.2</td><td colspan="2">50.0</td><td>12.2</td><td colspan="2">10.0</td></tr>
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<tr><td>500K</td><td>504</td><td colspan="3">300</td><td colspan="3">0.60</td></tr>
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<tr><td>5M</td><td>505</td><td></td><td>300</td><td></td><td></td><td>0.06</td><td></td></tr>
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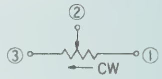
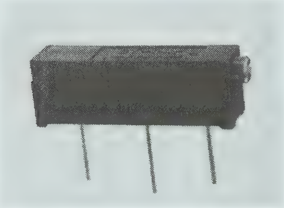
SERIES CT & TM

Multiturn Cermet Trimmers

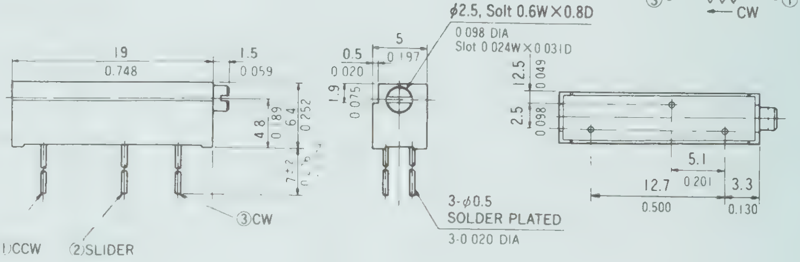
DIMENSIONS (in mm/inch)

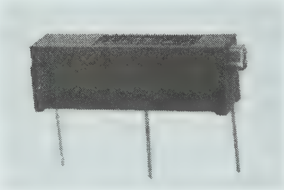
CT-20 (15 turn)
Unspecified tolerance: ±0.3mm/±0.012 inch



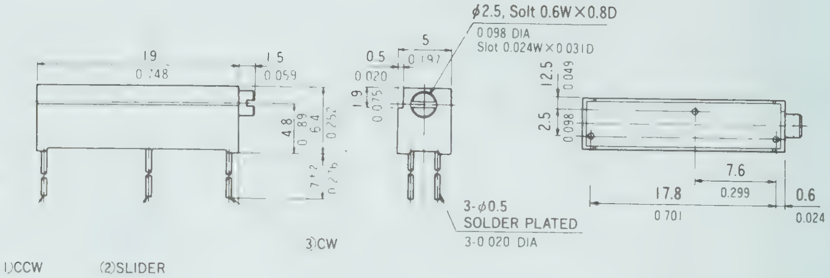


CT-20P
Side adjustment

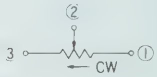


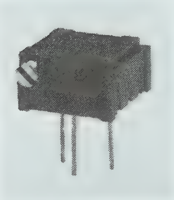


CT-20X
Side adjustment

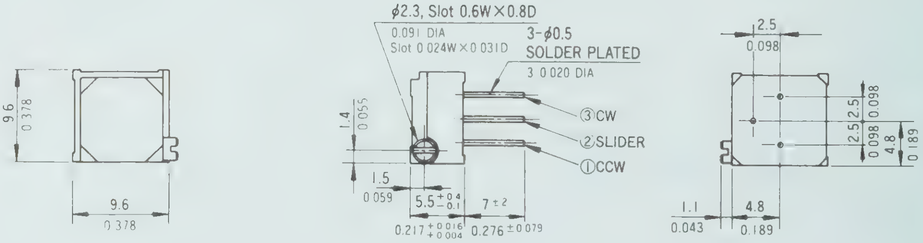


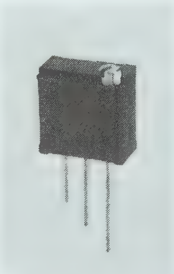
CT-9 (18 turn)
Unspecified tolerance: ±0.3mm/±0.012 inch



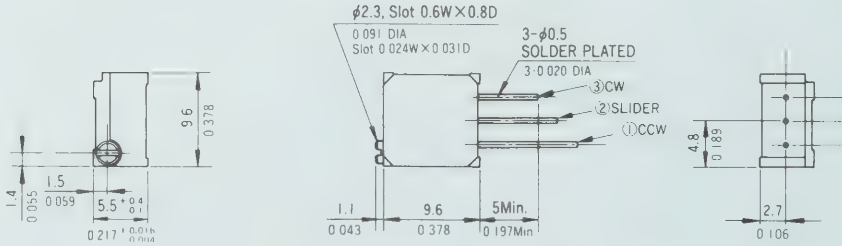


CT-9P
Side adjustment





CT-9W
Top adjustment



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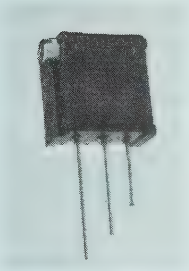
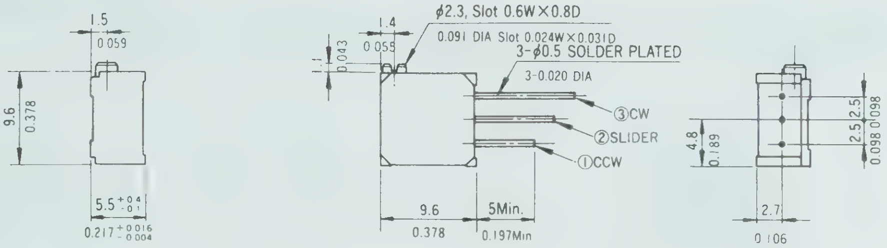
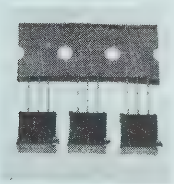
Cermet Trimmers

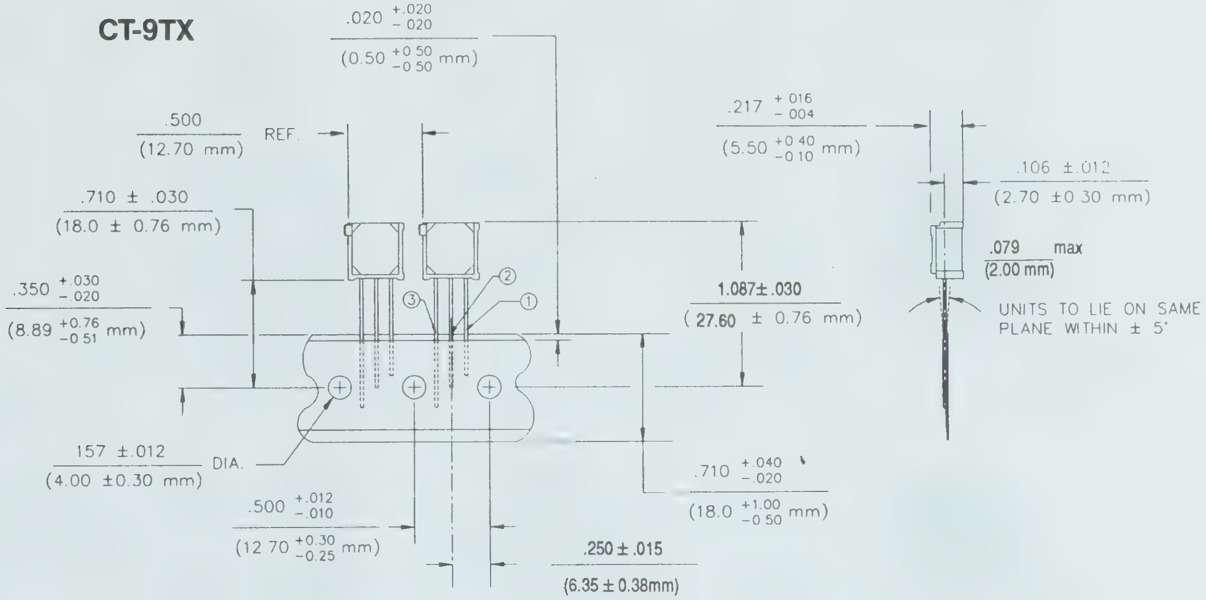


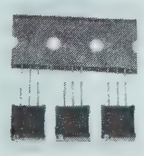
CT-9X
Side adjustment



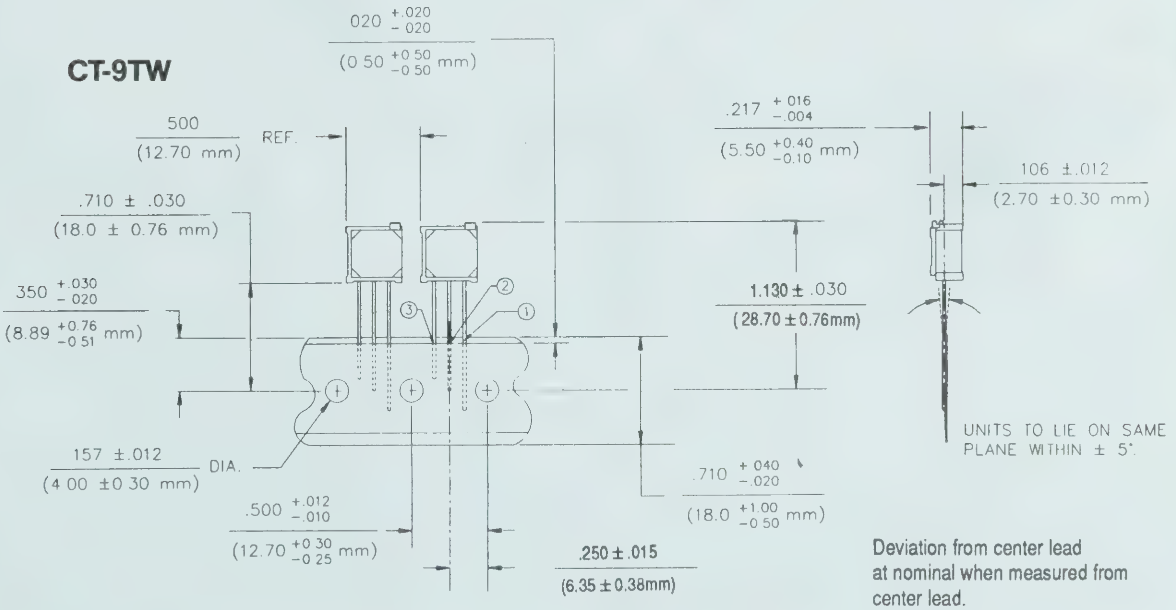


CT-9TX





CT-9TW

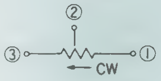


Deviation from center lead at nominal when measured from center lead.

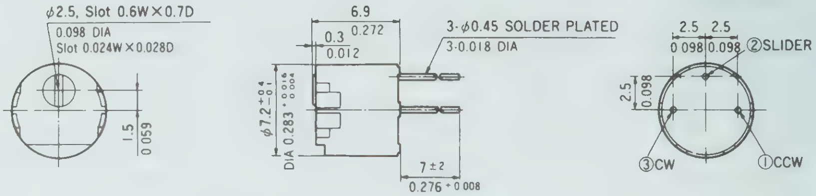
SERIES CT & TM

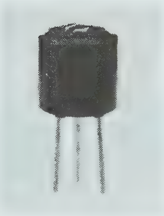
Multitum Cermet Trimmers

TM-7 (3 turn)
Unspecified tolerance: ±0.3mm/±0.012 inch

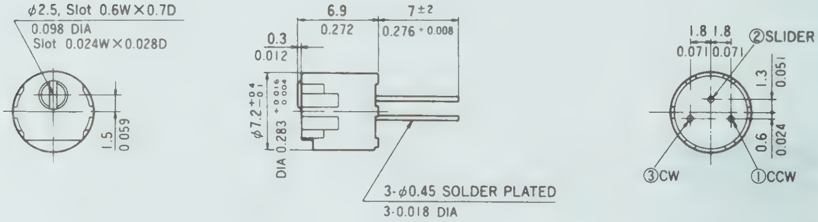


TM-7P
Top adjustment

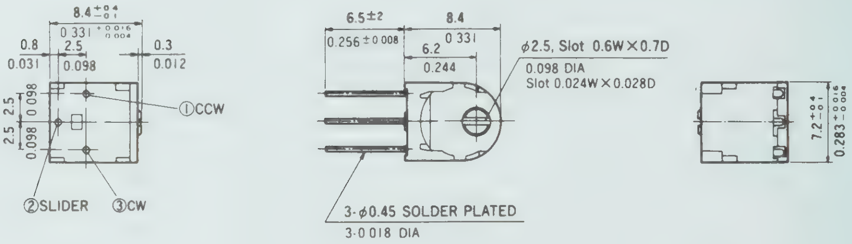


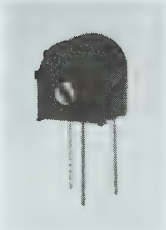


TM-7W
Top adjustment

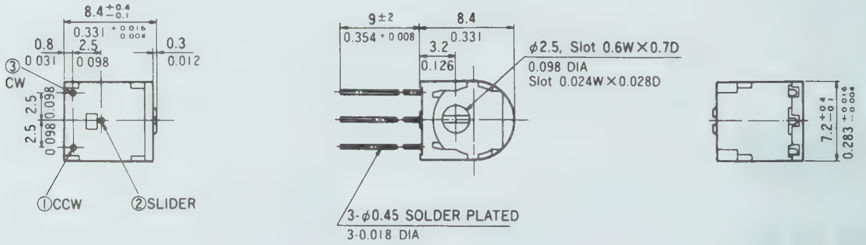


TM-7S
Side adustment





TM-7X
Side adjustment



SERIES 2322-410/483/482/484

Single Turn Consumer Grade Trimmers

RATINGS AND CHARACTERISTICS

	CARBON		CERMET	
	OPEN 410	ENCLOSED 483	OPEN 482	ENCLOSED 484
Resistance range:	47 ohm-4.7M	100 ohm-4.7M	100 ohm-10Mohm	47 ohm-10Mohm
Standard tolerances:	±20%	±20% and ±10%	±20% and ±10%	±20% and ±10%
Temperature characteristic of resistance: (20° to 70°C) For 100 ohm ≤R ≤470 ohm For 1kohm ≤ R ≤ 2M2 For R = 4, 7Mohm For R < 100 ohm	≤ +300 ppm/°C ≥ −500 ppm/°C	±500 ppm/°C ±300 ppm/°C ±1000 ppm/°C	±100 ppm/°C	±100 ppm/°C ±250 ppm/°C
Power rating:	.1 watt @ 40°C .05 watt @ 70°C	.1 watt @40°C .05 watt @ 70°C .025 watt @ 85°C	.5 watt @ 70°C derated linearly to 0 watt @125°C	.5 watt @ 70°C derated linearly to 0 watt @125°C
Operating voltage:	150 V max	150 V max	250 V max	250 V max
Isolation voltage:	220 V	220 V	220 V	220 V
Max. operating temp.	70°C	85°C	125°C	125°C
Vibration severity:	10 Hz to 500Hz 0.75mm or 98 m/s^2 (whichever is less)	10 Hz to 500Hz 0.75mm or 98 m/s^2 (whichever is less)	10 Hz to 500 Hz, 0.75mm or 98 m/s^2 (whichever is less)	10 Hz to 500 Hz, 0.75mm or 98 m/s^2 (whichever is less)
Bump severity:	390m/s^2-4000 bumps		390m/s^2-4000 bumps	390m/s^2-4000 bumps
Limits of resistance change (a to c) (after 1000 h electrical endurance test)	± (10% R + 0.5ohm)	±(10% R + 0.5ohm) ±(20% R + 1ohm) for value 4.7M	± (2% R + 0.2ohm)	± (2% R + 0.2ohm)
Starting torque:	3.5 to 25mNm	1.5 to 10mNm	<30mNm	<30mNm
Running torque:		2 to 10mNm ratio $\frac{max}{min} \leq 3$	3 to 20 mNm	3 to 20 mNm ratio $\frac{max}{min} \leq 3$
Total mechanical travel:	260° ±5°	300° ±5°	235° ±5°	300° ±5°
Effective electrical travel:	200° ±10°	285° ±10°	200° ±10°	285° ±10°
Limiting slider current:	Details of specification available on request	$\sqrt{\frac{Pmax}{Rnom}}$	$\sqrt{\frac{Pmax}{Rnom}}$	$\sqrt{\frac{Pmax}{Rnom}}$
Minimum effective resistance:	≤ 2% R or 10 ohm			
Terminal resistance:	≤ 100 mohm	≤ 2%R or 10 ohm (whichever is greater)	≤ 0.5%R or 2 ohm (whichever is greater)	≤ 0.5%R or 2 ohm, (whichever is greater)

PACKAGING

CARBON		CERMET	
OPEN 410	ENCLOSED 483	OPEN 482	ENCLOSED 484
BULK	BULK or ANTI-STATIC RAILS	BULK	BULK or ANTI-STATIC RAILS

MARKING

OPEN CARBON (410)

The potentiometer is marked with the rated resistance value.

e.g. 220 ohm = 220R
10 kohm = 10K
1 Mohm = 1MO

The rated resistance value is designed in R.K.M. code according to IEC 62 with letter (number) punches on the wiper or knob.

The package is marked with: —code number
—date of production
—quantity

ENCLOSED CARBON (483) / CERMET (484)

The potentiometers are marked with the rated resistance value.

e.g. 220 ohm = 220R
10 kohm = 10K
1 Mohm = 1MO

The rated resistance value is designed in R.K.M. code according to IEC 62 with letter (number) marked with stamping ink on the front side.

The package is marked with: —code number
—date of production
—quantity

OPEN CERMET (482)

The potentiometer is marked with the rated resistance value.

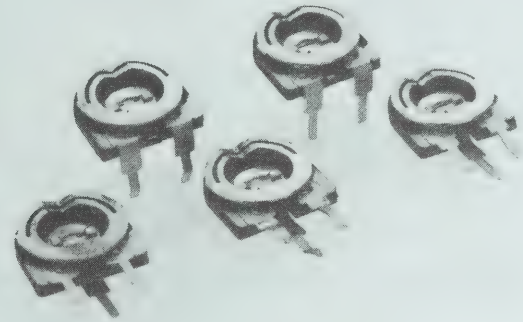
e.g. 220 ohm = 220R
10 kohm = 10K
1 Mohm = 1MO

The rated resistance value is designed in R.K.M. code according to IEC 62 with letter (number) punches on the wiper.

The package is marked with: —code number
—date of production
—quantity

SERIES 2322-410

10mm Open Carbon Trimmers



HOW TO SPECIFY

2322 410 X XX XX

Code	Potentiometer Type
0	Without knob
4	Flat knob Type I Rem. 1
6	Flat knob Type II Rem. 2

Code	Version
11	Vertical version Plug-in type Longitudinal slot (raised version)

Code	Version
33	Horizontal version Plug-in type Longitudinal slot
50	Vertical version Plug-in type Longitudinal slot (normal version)

Code	Resistance Value
51	100Ω
52	220Ω
53	470Ω
54	1kΩ
55	2,2kΩ
56	4,7kΩ
57	10kΩ
58	22kΩ
59	47kΩ
61	100kΩ
62	220kΩ
63	470kΩ
64	1MΩ
65	2,2MΩ
66	4,7MΩ
69	330Ω
91	47Ω

Rem. 1:
Designed for
versions: 2322 410 050

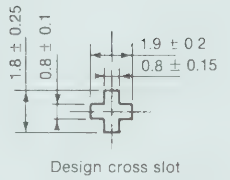
Rem. 2:
Designed for
versions: 2322 410 011
033

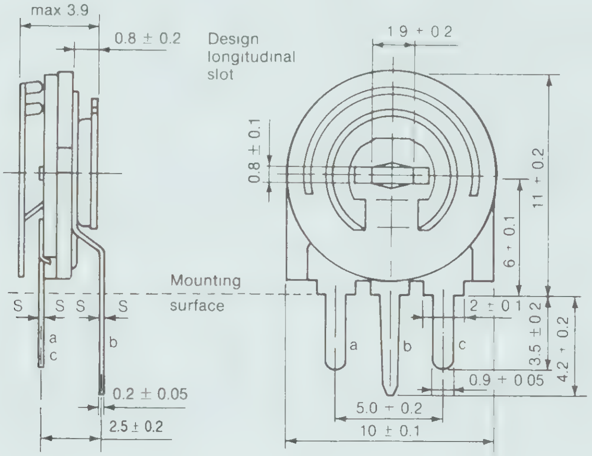
SERIES 2322-410

10mm Open Carbon Trimmers

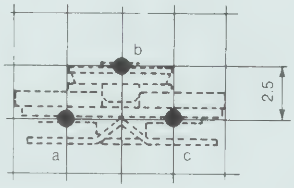
2322-410-011

Note: — Surfaces marked with "S" are solderable.
— No dimensions for gauging.
— Dimensions in mm



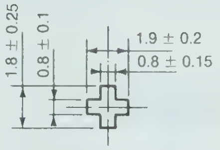


Hole pattern for P.W. board
- Pierced component hole: Ø 1mm
- P.W.-board thickness 1.6 +0.24/−0.14

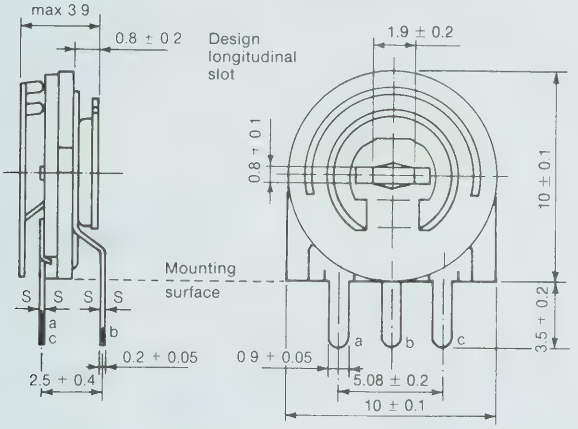


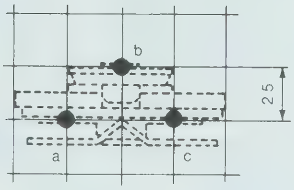
Note: — Surfaces marked with "S" are solderable.
— No dimensions for gauging.
— Dimensions in mm.

2322-410-050



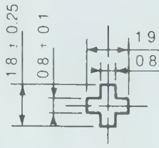
Design cross slot





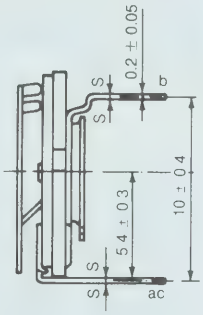
Hole pattern
for P.W. board
- Pierced component hole: Ø 1mm
- P.W.-board thickness 1.6 +0.24/−0.14

Note: — Surfaces marked with "S" are solderable
— No dimensions for gauging.
— Dimensions in mm.

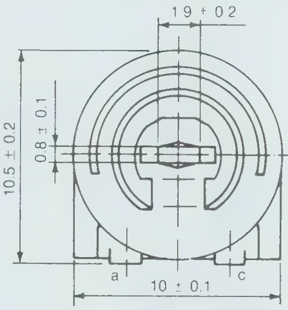


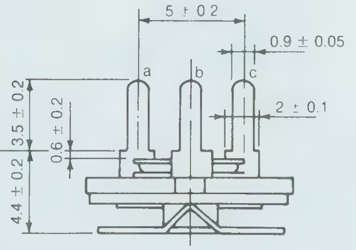
Design cross slot

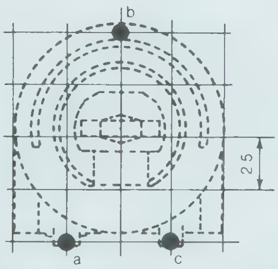
2322-410-033



Design
longitudinal
slot



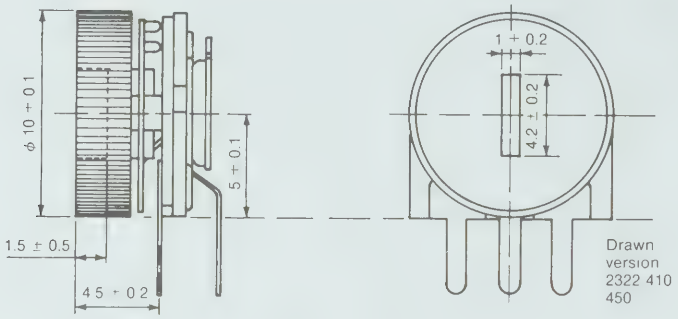




Hole pattern
for P.W. board
- Pierced component hole: Ø 1mm
- P.W.-board thickness 1.6 +0.24/−0.14

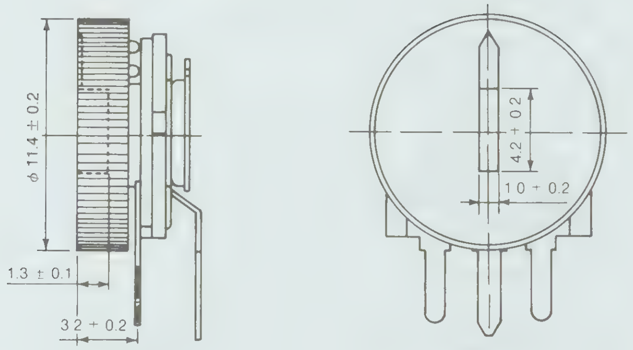
SERIES 2322-410

10mm Open Carbon Trimmers

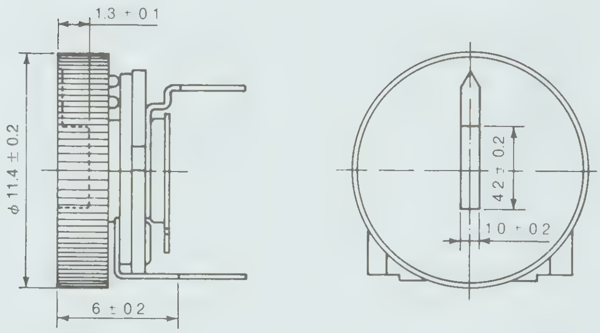


2322-410-450

Note: — No dimensions for gauging.
For other data see Appendix A



2322-410-611

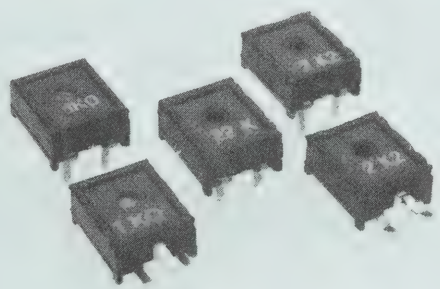


2322-410-633

These potentiometers offer stable, high quality performance and can be mounted by automatic insertion machines. They are designed for video, audio and industrial applications. Versions with a knob to facilitate adjustment are available.

SERIES 2322-483

10mm Enclosed Carbon Trimmers



HOW TO SPECIFY

2 3 2 2   483   X   X   XXX

Code	Potentiometer Type
0 Rem.1	Vertical Non-Insulated cross slot
1	Vertical Insulated hexagonal slot
2	Vertical Insulated cross slot
5	Horizontal Non-insulated cross slot
6	Horizontal Insulated hexagonal slot
7	Horizontal Insulated cross slot

Rem. 1:
No snap-in tags.

Code	Law + Tolerance – Type PW Tags – Packaging
0	–
1	–
2	LIN ±20% Snap-in tags Bulk packaging
3	LIN ±10% Snap-in tags Bulk packaging
4	LIN ±20% Slide tags Bulk packaging
5	LIN ±10% Slide tags Bulk packaging
6	LIN ±20% Snap-in tags Rail packaging
7	LIN ±10% Snap-in tags Rail packaging
8	LIN ±20% Slide tags Rail packaging
9	LIN ±10% Slide tags Rail packaging

Code	Resistance Value
101	100Ω
221	220Ω
471	470Ω
102	1kΩ
222	2,2kΩ
472	4,7kΩ
103	10kΩ
223	22kΩ
473	47kΩ
104	100kΩ
224	220kΩ
474	470kΩ
105	1MΩ
225	2,2MΩ
475	4,7MΩ

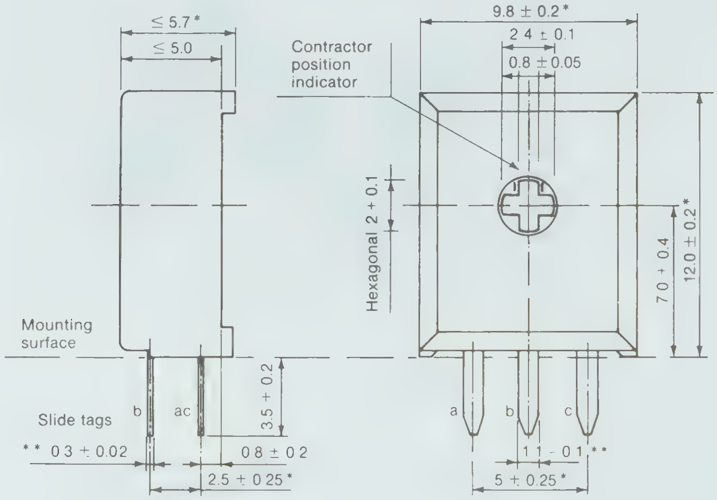
These potentiometers are for preset resistance control with provisions for readjustment. They are particularly suitable for use in radio and television receivers. This series includes types for vertical and horizontal mounting on printed circuit boards. Snap-in pins and cross slot are available on request.

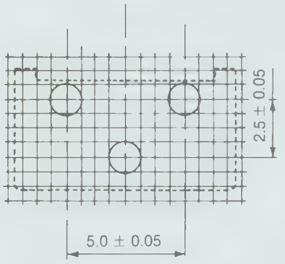
SERIES 2322-483

10mm Enclosed Carbon Trimmers

2322-483-02 . . . thru 09

Vertical version, non-insulated hot wiper with cross slot.





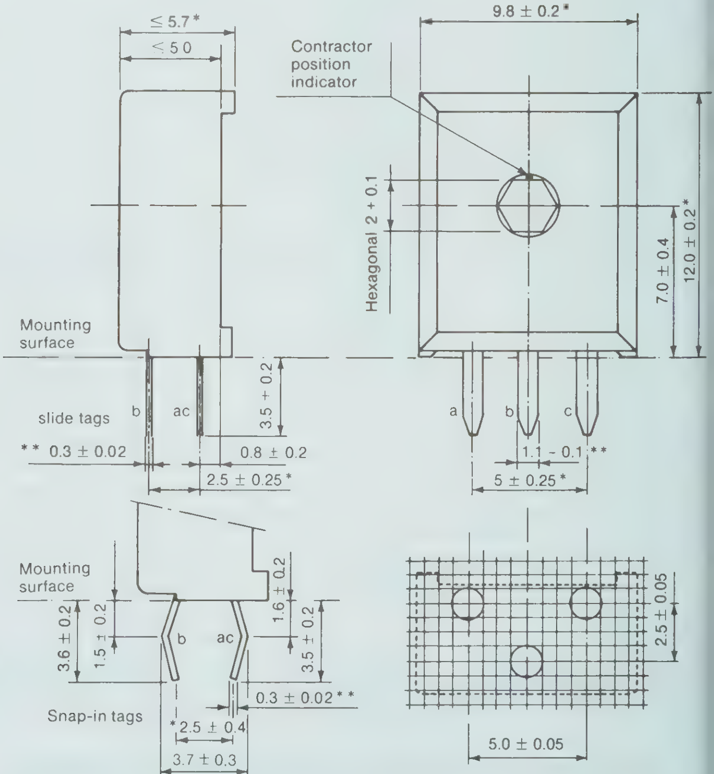
Rem.: Snap-in tags available

Dimensions in mm
* For gauging
** Incl. burrs: max. 04. × 1.2

Hole pattern for P.W. board:
Pierced component hole: Ø 1.3
P.W. board thickness: 1.6 + 0.24
 - 0.14

2322-483-12 . . . to/incl. 19

Vertical version, insulated cold wiper with hexagonal slot.



Hole pattern for P.W. board:
Pierced component hole: Ø 1.3
P.W. board thickness: 1.6 + 0.24
 - 0.14

Dimensions in mm
* For gauging
** Incl. burrs: max. 04. × 1.2

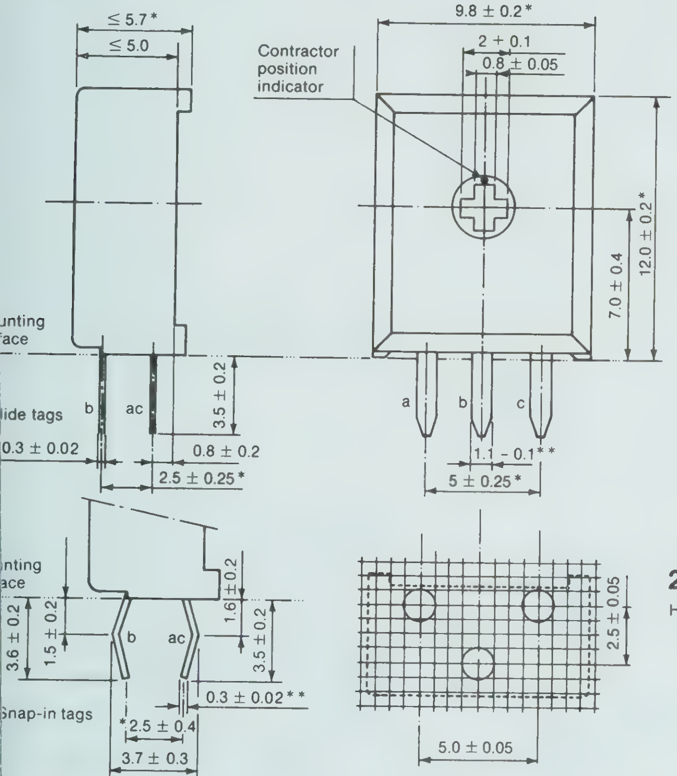
7

Cermet Trimmers

Mepcopal Company • 11468 Sorrento Valley Road • San Diego, CA 92121 • (619) 453-0332 • FAX: (619) 481-1123

322-483-22 . . . thru 29

rtical version, insulated cold wiper with cross slot.

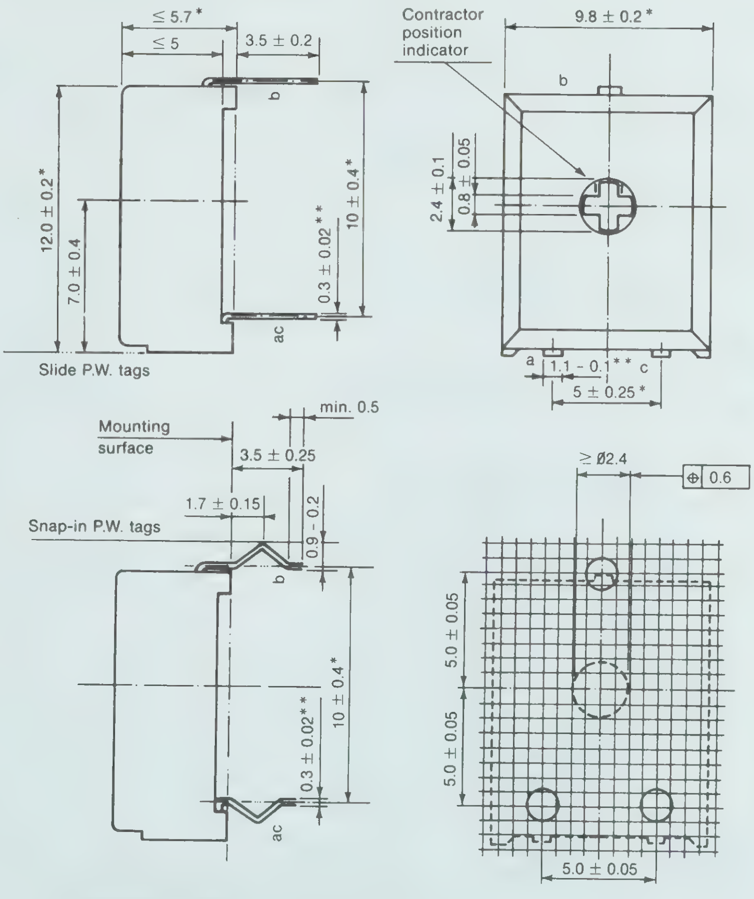


le pattern for P.W. board:
rced component hole: Ø 1.3
/. board thickness: 1.6 + 0.24
- 0.14

Dimensions in mm
* For gauging
** Incl. burrs: max. 04. × 1.2

2322-483-52 . . . thru 59

Horizontal version, non-insulated hot wiper with cross slot.



Hole pattern for P.W. board:
Pierced component hole: Ø 1.3
P.W. board thickness: 1.6 + 0.24
- 0.14

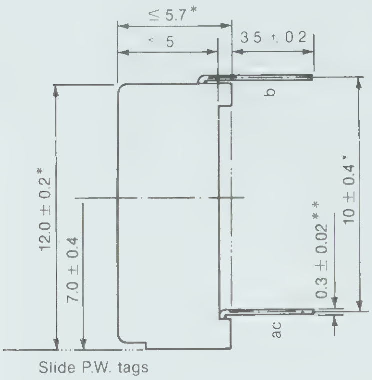
Dimensions in mm
* For gauging
** Incl. burrs: max. 04. × 1.2

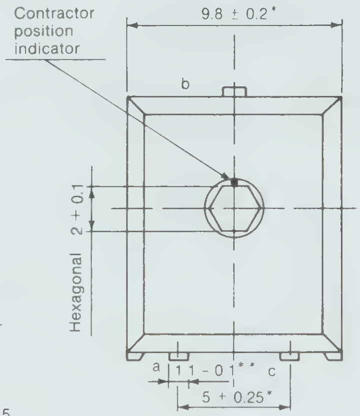
SERIES 2322-483

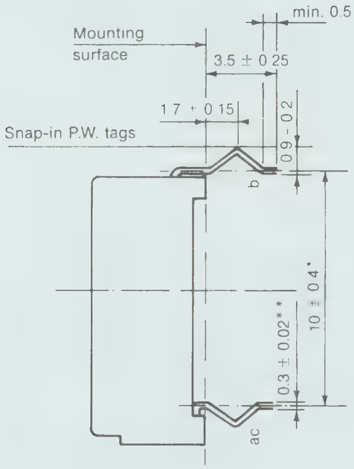
10mm Enclosed Carbon Trimmers

2322-483-62 . . . thru 69

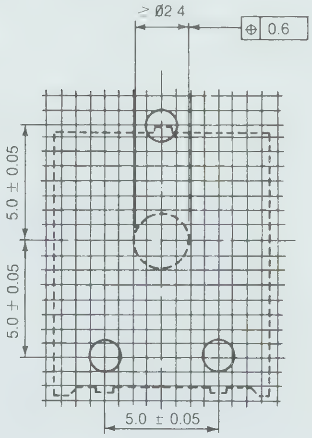
Horizontal version, insulated cold wiper with hexagonal slot.







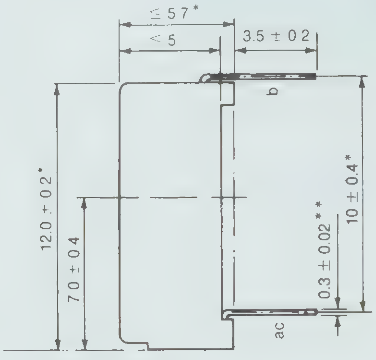
Hole pattern for P.W. board:
Pierced component hole: Ø 1.3
P.W. board thickness: 1.6 + 0.24
- 0.14

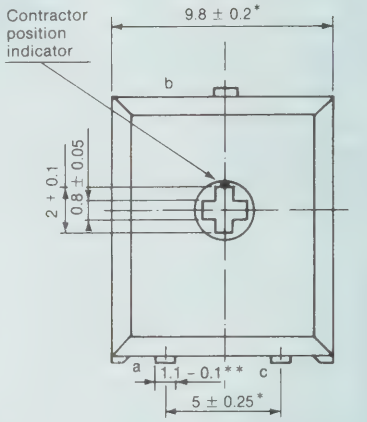


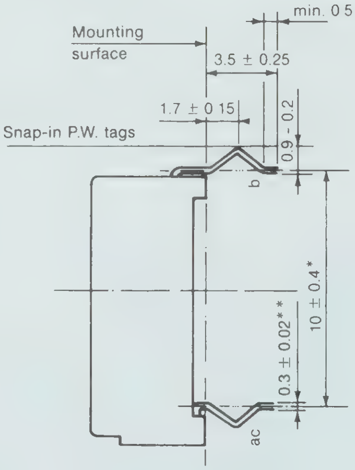
Dimensions in mm
* For gauging
** Incl. burrs: max. 04. × 1.2

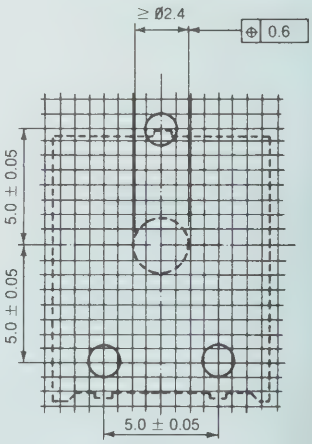
2322-483-72 . . . thru 79

Horizontal version, insulated cold wiper with cross slot.









Hole pattern for P.W. board:
Pierced component hole: Ø 1.3
P.W. board thickness: 1.6 + 0.24
- 0.14

Dimensions in mm
* For gauging
** Incl. burrs: max. 04. × 1.2

SERIES 2322-482
10mm Open Cermet Trimmers

HOW TO SPECIFY

2322 482 X X XXX

Code	Potentiometer Type
2	Horizontal (asymmetric) Longitudinal slot
3	Vertical Longitudinal slot
4	Horizontal (symmetric) Longitudinal slot
6	Horizontal (asymmetric) Cross slot
7	Vertical Cross slot
8	Horizontal (symmetric) Cross slot

Code	Tolerance	Law
0	20%	Lin
2	10%	Lin

Code	Resistance Value
101	100Ω
151	150Ω
221	220Ω
331	330Ω
471	470Ω
681	680Ω
102	1kΩ
152	1,5kΩ
222	2,2kΩ
332	3,3kΩ
472	4,7kΩ
682	6,8kΩ
103	10kΩ
153	15kΩ
223	22kΩ
333	33kΩ
473	47kΩ
683	68kΩ
104	100kΩ
154	150kΩ
224	220kΩ
334	330kΩ
474	470kΩ
684	680kΩ
105	1MΩ
155	1,5MΩ
225	2,2MΩ
335	3,3MΩ
475	4,7MΩ
685	6,8MΩ
106	10MΩ

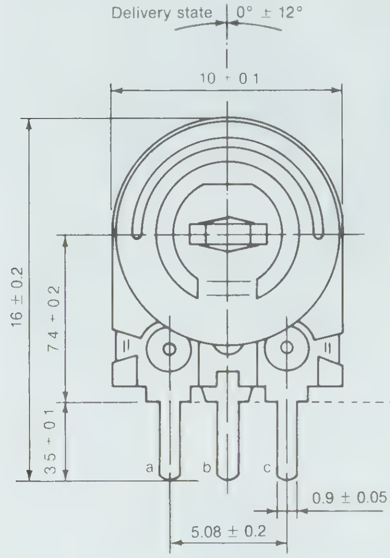
These potentiometers are for preset resistance control with provision for re-adjustments. They are particularly suitable for use in professional apparatus and/or in those applications where stability is of extreme importance. They are available in versions for horizontal and vertical mounting on printed circuit boards.

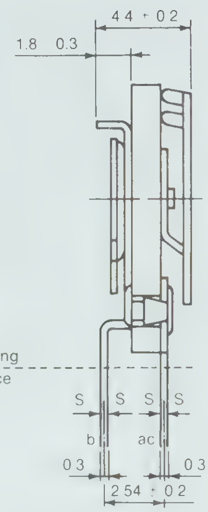
SERIES 2322-482

10mm Open Cermet Trimmers

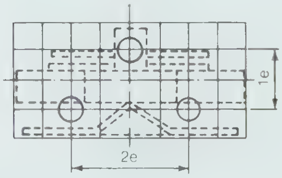
2322 482 3 . . . . (Longitudinal slot)
and 7 . . . . (cross slot)

Surfaces marked with "S" are solderable.



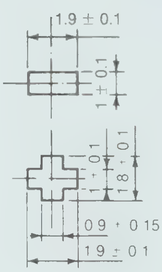


Hole pattern for mounting on a printed wiring-board.



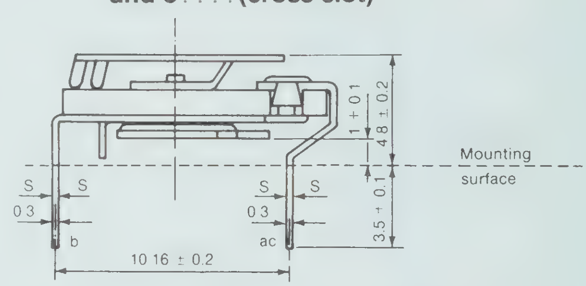
e = 2.54mm
Hole dia : 1.3 ± 0.13mm
All dimensions in mm

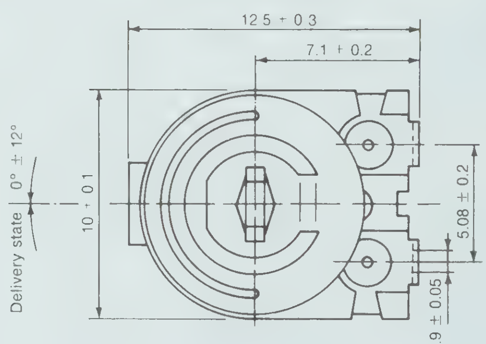
Design actuating slot



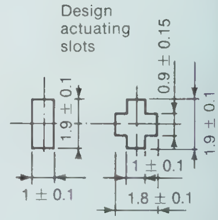
Note: — Surfaces marked with "S" are solderable.

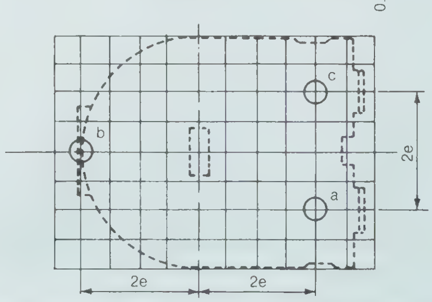
2322 482 4 . . . . (Longitudinal slot)
and 8 . . . . (cross slot)





Design actuating slots





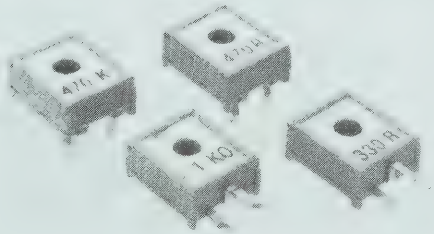
e = 2.54mm
Hole pattern for mounting on a printed wiring board
Hole dia: 1.3 ± 0.13mm
Dimensions in mm.

7

Cermet Trimmers

SERIES 2322-484

10mm Enclosed Cermet Trimmers



HOW TO SPECIFY

2322 484 X X XXX

Code	Potentiometer Type
–	–
1	Vertical Insulated hexagonal slot
2	Vertical Insulated cross slot
–	–
6	Horizontal Insulated hexagonal slot
7	Horizontal Insulated cross slot

Code	Law + Tolerance – Type PW Tags – Packaging
0	–
1	–
2	LIN ±20% Snap-in tags Bulk packaging
3	LIN ±10% Snap-in tags Bulk packaging
4	LIN ±20% Slide tags Bulk packaging
5	LIN ±10% Slide tags Bulk packaging
6	LIN ±20% Snap-in tags Rail packaging
7	LIN ±10% Snap-in tags Rail packaging
8	LIN ±20% Slide tags Rail packaging
9	LIN ±10% Slide tags Rail packaging

Code	Resistance Value
479	47Ω
689	68Ω
101	100Ω
151	150Ω
221	220Ω
331	330Ω
471	470Ω
681	680Ω
102	1kΩ
152	1,5kΩ
222	2,2kΩ
332	3,3kΩ
472	4,7kΩ
682	6,8kΩ
103	10kΩ
153	15kΩ
223	22kΩ
333	33kΩ
473	47kΩ
683	68kΩ
104	100kΩ
154	150kΩ
224	220kΩ
334	330kΩ
474	470kΩ
684	680kΩ
105	1MΩ
155	1,5MΩ
225	2,2MΩ
335	3,3MΩ
475	4,7MΩ
685	6,8MΩ
106	10MΩ

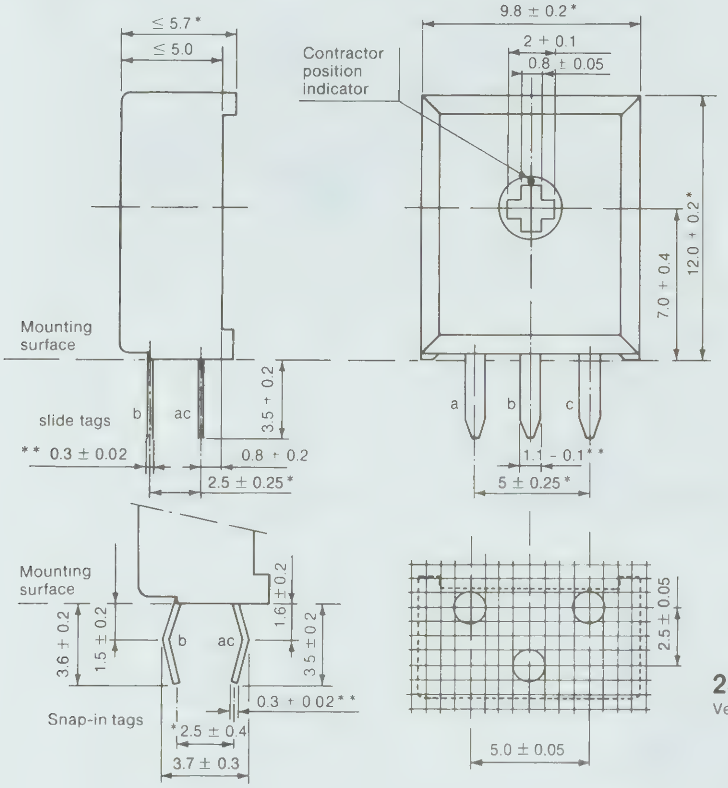
These potentiometers offer stable high quality performance and can be mounted by automatic insertion machines. They are designed for video, audio, and industrial applications. Versions for vertical and horizontal mounting are available. A hexagonal slot version can be provided with a knob to facilitate manual adjustment.

SERIES 2322-484

10mm Enclosed Cermet Trimmers

2322 484 22 . . . to/incl. 29 . . .

Vertical version, insulated cold wiper with cross slot.

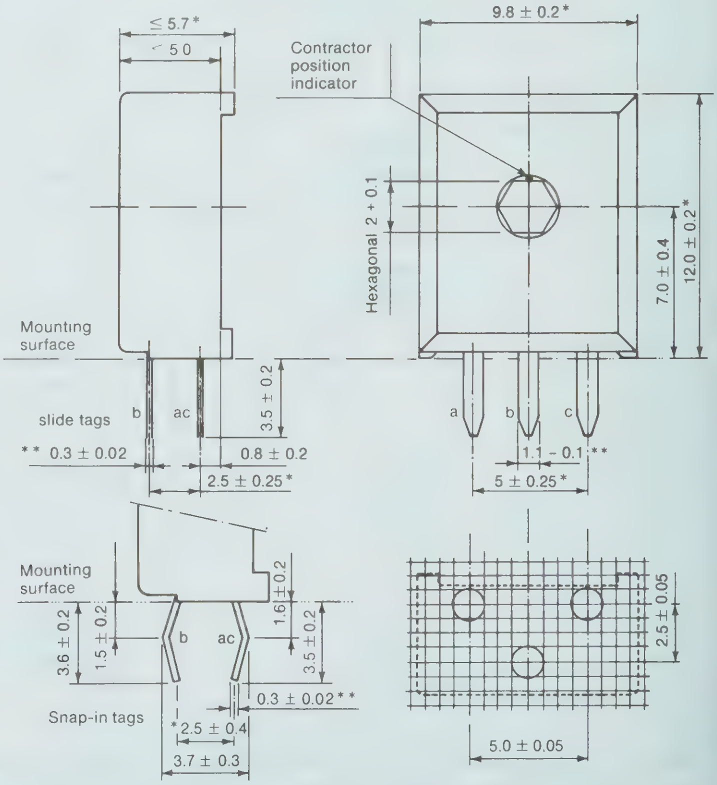


Hole pattern for P.W. board:
Pierced component hole: Ø 1.3
P.W. board thickness: 1.6 + 0.24
− 0.14

Dimensions in mm
* For gauging
** Incl. burrs: max. 04. × 1.2

2322 484 12 . . . to/incl. 19 . . .

Vertical version, insulated cold wiper, hexagonal slot.



Hole pattern for P.W. board:
Pierced component hole: Ø 1.3
P.W. board thickness: 1.6 + 0.24
− 0.14

Dimensions in mm
* For gauging
** Incl. burrs: max. 04. × 1.2

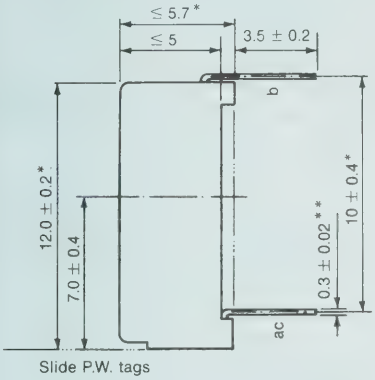
Mepcopal Company • 11468 Sorrento Valley Road • San Diego, CA 92121 • (619) 453-0332 • FAX: (619) 481-1123

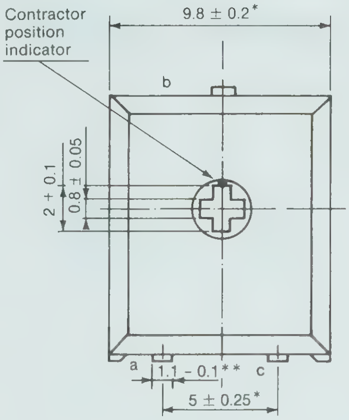
SERIES 2322-484

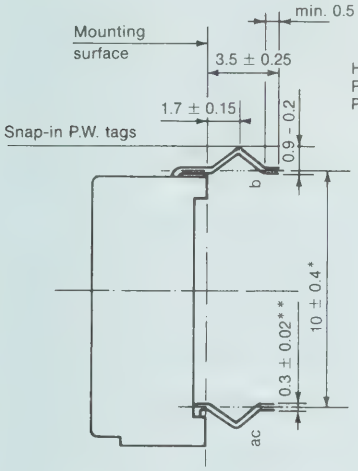
10mm Enclosed Cermet Trimmers

2322 484 72. . . thru 79. . .

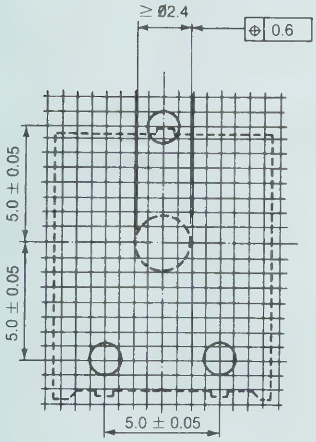
Horizontal version, insulated cold wiper with cross slot.







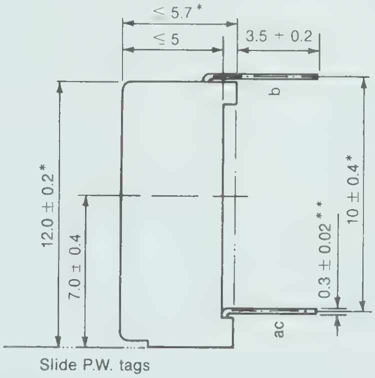
Hole pattern for P.W. board:
Pierced component hole: Ø 1.3
P.W. board thickness: 1.6 + 0.24
- 0.14

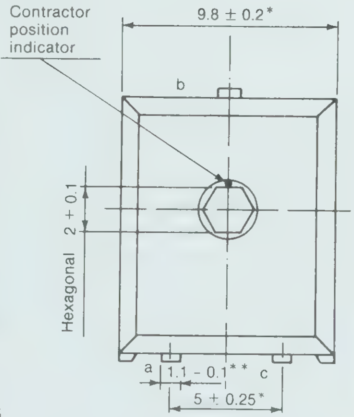


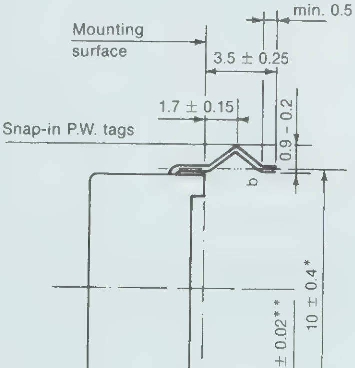
Dimensions in mm
* For gauging
** Incl. burrs: max. 04. × 1.2

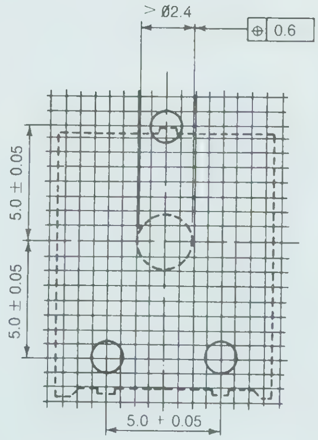
2322 484 62. . . thru 69. . .

Horizontal version, insulated cold wiper with hexagonal slot.









Hole pattern for P.W. board:
Pierced component hole: Ø 1.3
P.W. board thickness: 1.6 + 0.24
- 0.14

Dimensions in mm
* For gauging
** Incl. burrs: max. 04. × 1.2

Non-Linear Resistors
QUICK REFERENCE INDEX

METAL OXIDE VARISTORS: UL FILE #E 98144 VDE FILE #14480-4790-1001/A1F

Philips Components Series	Size Range Inches (mm)	R.M.S. Working Voltage	DC Voltage	Insulation Voltage	Maximum Non-Repetitive Transient Current	Page
592 thru 596	.276 to .945 (7 to 24)	14 to 550	18 to 745	2500V	50-6500A	573-594
NTC Thermistors						595

Philips Components Series	Style and Size Range	Resistance Range 25°C (ohms)	B-Value 25°C-85°C °K	Maximum Dissipation (watts)	Thermal† Time Constant (seconds)	Operating Temperature Range (°C)	Page
610-0	LEADLESS DISC	4 to 33	2800 to 3250	1.0	60	−25 to +125	600
610-1	RADIAL LEADS	4 to 33	2800 to 3250	1.0	60	−25 to +125	601
626-1	GLASS PROBE HIGH TEMP	1,000 to 1,000,000	2075 to 4100	.100	10	−55 to +300	602
626-2	GLASS PROBE HIGH TEMP	1,000 to 1,000,000	2075 to 4100	.100	7.5	−55 to +300	603
633-0	MINIATURE BEADS RADIAL LEADS	1,000 to 1,000,000	2075 to 4100	.025	8.5	−55 to +200	604
633-1	MINIATURE BEADS AXIAL LEADS	1,000 to 1,000,000	2075 to 4100	.025	8.5	−55 to +200	605
633-2	GLASS PROBE	1,000 to 1,000,000	2075 to 4100	.060	6.0	−55 to +200	606
640-6	RADIAL LEADS	2,700 to 470,000	3977 to 4570	.250	11.0	−40 to +150	607
640-9	STEEL HOUSING	2,700 to 12,000	3700 to 3997	.250	285.0	−25 to +130	614
642-6	RADIAL LEADS	3.3 to 2,200	2675 to 4125	.500	17.0	−40 to +150	615
642-7	ALUMINUM HOUSING	3.3 to 2,200	2675 to 4125	.500	7.5	−40 to +150	619
644-9	CURRENT LIMITING	2.5 to 82	2975 to 4650	2.5 to 7.4	115 to 148	−25 to +155	623
645-0	RADIAL LEADS	5,000 to 10,000	3965	.100	8.5	−40 to +150	627

†**Thermal Time Constant:** The time (in seconds) required for a thermistor to change 63.2% of the total difference between its initial and final body temperature, when subjected to step-function change in temperature under zero-power conditions.

PTC Thermistors						629
Philips Components Series	Style and Size Range	Resistance Range 25°C (ohms)	Switch Temperature °C	Maximum Voltage		Page
660	RADIAL LEADS	5 to 250	80 to 150	25 VDC		649
661	RADIAL LEADS	30 to 50	25 to 110	50 VDC		651
662	RADIAL LEADS	36 to 120	75 to 115	265 VRM 3		653

8 Non-Linear Resistors

Non-Linear Resistors
QUICK REFERENCE INDEX

Philips Components Series	Style and Size Range	Resistance Range 25°C (ohms)	Peak Inpush Current (A)	Rated Coil Resistance	Residual Current at 180 seconds	Page
662-96	DUAL DEGAUSSER	8 to 43	5.0 to 20.0	140 to 265 VRMS 6.2 ohms to 25 ohms	15 MA to 0.5 MA	655

Philips Components Series	Style and Size Range	Resistance Range 25°C (ohms)	Switch Temperature (°C)	Trip Current	Non-trip Current	Page
66	CURRENT OVERLOAD	1.0 to 1900	120	56 to 265 VRMS 12 mA to 68 omA	24 mA to1360 mA	657
672	OVER TEMPERATURE	30 to 250	70 to 150 (10°C MULTIPLES)	25 VDC		681
680-04	HEATER ASSEMBLIES		160 to 220	145 to 265 VRMS		679
680-93	HEATER CERAMICS		115 to 245	145 to 265 VRMS		683

HUMIDITY SENSOR

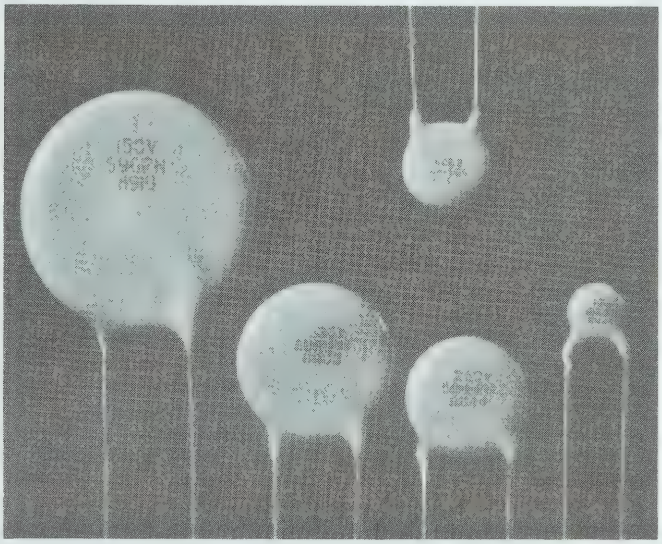
Philips Components Series	Capacitance at 25°C, 43% RH, 100 KHz	Sensitivity 33 to 43% RH	Maximum Voltage	Humidity Range	Page
691	122 PF ± 15%	0.4 ± .05 PF/ 9. RH	15 AC/DC	10 to 90%	684

 Philips Components • Airport Road, P.O. Box 760 • Mineral Wells, TX 76067 • (817) 325-7871 • FAX: (817) 325-1052

METAL OXIDE VARISTORS

Zinc Oxide Voltage Dependent Resistor

U.L. File #E98144 VDE File #14480-4790-1001/A1F



DESCRIPTION

GENERAL

V(oltage) D(ependent) R(esistor)—varistors—have a high degree of non-linearity between resistance value and applied voltage. This characteristic is created by non-homogeneous metal oxide materials selected for rectifying action at the interface of two crystals. The electrical characteristic of the component is the product of a large number of these interstitial junctions, forming a complex network of series and parallel rectifying junctions.

The Philips Components product line uses ZnO (with doping) as the element material. ZnO offers much sharper V-I curves than other commonly used materials.

PHYSICAL

A disc of low beta metal oxide ceramic with two solid tinned copper wires. ZnO's are epoxy coated.

ELECTRICAL DATA, see also Table 1 and subsequent curves.

Climatic category	40/125/56
Insulation voltage	2500 V
Temperature coefficient of voltage at 1 mA	–0.065%/°C
Derating (see Fig. 31.)	

Mounting

Series 592 thru 595 available on	Tape & Reel.
Series 592 and 593 available on	Ammo Pack

Soldering

Solderability	max. 240°C, max. 4s
Resistance to heat	max. 265°C, max. 11s

Impact

free fall	39.4" (1000 mm)

Termination Strength

Tensile strength	2.25 lb (10 N)
Bending	1.12 lb (5 N)
Flammability	Nonflammable

METAL OXIDE VARISTORS

INTRODUCTION TO METAL OXIDE VARISTORS

Metal Oxide Varistors, also called V(oltage) D(ependent) R(esistors), show a high degree of non-linearity between their resistance value and the applied voltage. They are made of non-homogeneous material giving a rectifying action at the contact of two particles. The electrical characteristic of the conglomeration is determined by a large number of crystal contacts which form a complicated network of series and parallel rectifying contacts.

These resistors have found a diversity of applications in the different sectors of electronics. They offer an inexpensive and reliable solution for protection of electronic circuits, semiconductor components, collectors of motors, relay contacts, etc. against over-voltages and their consequences.

MANUFACTURING PROCESS

Crystals of metal oxides, with the right electrical and dimensional properties are pressed together with a ceramic binder to the shape of discs. After a drying period the varistors are sintered at a high temperature. Firing time, temperature and gaseous atmosphere have an important influence on the electrical characteristics. The contacts are metallized with silver enabling good electrical contact. After leads have been soldered to the contacts the varistors are epoxied and laser marked.

During and after the manufacturing process the electrical properties are controlled not only to ensure that the varistors are within the specification but also to control stability and reliability.

ELECTRICAL PROPERTIES

Direct Current

The relation between voltage and current of a varistor can be approximated by:

$$V = C\,I^{\beta}$$

where V is the voltage in volts, I the current in amperes and C and β are constants. This equation is illustrated in Fig. 1. In principle the same characteristic is plotted for a specific type on a double logarithmic scale in Fig. 2. For not too small values of current this relation is a straight line which follows directly from the equation log V = log C + β log I. In this case β is the directional coefficient of the straight line.

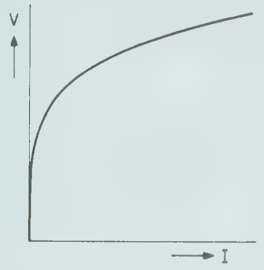


Fig. 1 Shape of the voltage/current characteristic of a varistor when plotted on a linear scale.

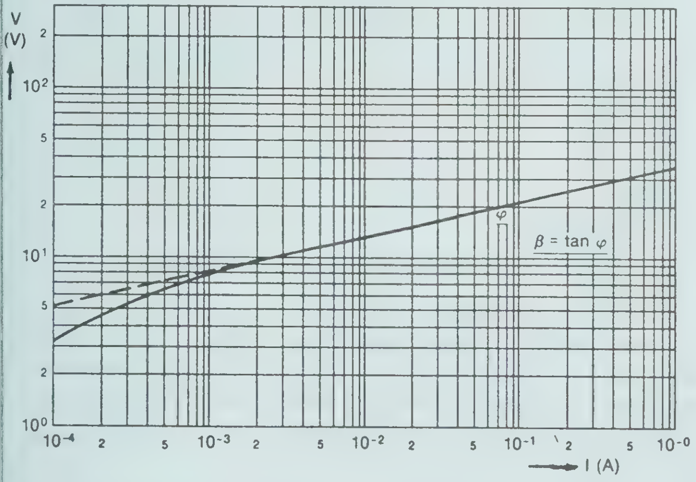


Fig. 2 Voltage/current characteristic of a varistor plotted on a logarithmic scale.

In order to determine the exact values of the constants C and β it is necessary to measure three points of the characteristic. Only when these are on a straight line when plotted on a double logarithmic scale, is extrapolation permitted (only to higher values). Equation (1) may also be written:

$$I = \left(\frac{V}{C}\right)^{\alpha} \qquad (2)$$

in which:

$$\alpha = 1/\beta \qquad (3a)$$

and

$$K = \frac{1}{C^{1/\beta}} = \frac{1}{C^{\alpha}} \qquad (3b)$$

The varistors do not have a polar effect; this means that when the voltage is changed from positive to negative, the current changes its direction, but retains its value. Strictly speaking, Eqs (1) and (2) are valid only when the absolute values are taken for I and V. In a.c. calculations this may be very important. For practical design, reference is made to the voltage/current characteristics given in the data sheets of the relevant varistor types.

Practical values and specification

The C and β-values of varistors depend on the composition of the material and on the method used in the processing; furthermore, the C-value depends on the shape and the dimensions of the varistor. Practical β-values are β = 0.02 to 0.035.

It is inherent to the material properties that the β-value of a varistor with a low C-value will always be higher than that of a varistor with a high C-value. Practical C-values range from 14 to a few thousand. As the method of fabrication compels a minimum thickness and, as will be seen further, enlarging of the surface area gives little change in the C-value, the latter has for practical reasons a limited lowest value.

According to Eq. (1) it is possible to specify the electrical characteristics of a varistor by giving its C and β-values. The advantage of this specification is that only two parameters are used. The disadvantage is, however, that due to the inevitable tolerances on the β-values, the spread in voltages at low currents (in the working area) becomes very large. It is for this reason that the method of specifying by the C-value defined at 1 A is abandoned and we now specify the voltage across the varistor at currents which lie in the working area (1, 10 or 100 mA instead of 1 A). In this way it is possible to supply varistors which have much closer tolerances in the area where they are used, see Fig. 5.

METAL OXIDE VARISTORS

Varistors in series

For each varistor we can write the equation:

$$V = CI^{\beta}. \qquad (1)$$

When n equal elements are connected in series and a voltage of n times the original voltage is applied, the current will be the same as for V volts over one varistor. Consequently we may write for a series circuit of n varistors:

$$nV = C' I^{\beta}. \qquad (4)$$

From Eqs (1) and (4) it is evident that,

$$C' = nC, \qquad (5)$$

which means that the C-value of a varistor can be increased by series connection.

Varistors in parallel

For one varistor again we have:

$$V = CI^{\beta}. \qquad (1)$$

When n of these varistors are connected in parallel and the same voltage V is applied, the current in each varistor will still be the same. The total current in the circuit will be nI. This gives the following equation:

$$V = C''(nI)^{\beta}. \qquad (6)$$

From Eqs (1) and (6) it follows:

$$C'' = \frac{C}{n^{\beta}} \qquad (7)$$

As varistors have a β-value from 0.02 to 0.40, it is clear that the C-value will decrease very little by connecting two or more elements in parallel. When, e.g. β = 0.20, 32 varistors are needed for a 50% reduction of the C-value. It is important that in parallel circuits all varistors have about the same β and C-values, otherwise the current division will very much depend on the voltage across the circuit.

Note: On no occasion may a varistor be connected in parallel with the aim of obtaining higher power dissipation.

Resistance value

When defining R as usual as the quotient of voltage and current, we find:

$$R = \frac{V}{I} = \frac{CI^{\beta}}{I} = \frac{C}{I^{1-\beta}} \qquad (8)$$

or when starting from the form $I = (\frac{V}{C})^{\alpha}$:

$$R = \frac{V}{I} = \frac{V}{\frac{V^{\alpha}}{C^{\alpha}}} = \frac{C^{\alpha}}{V^{\alpha-1}} \qquad (9)$$

From these equations it is once more evident that the resistance value is not a constant one, but is very much dependent on the values of voltage and current.

Dissipated power

The power dissipated in a varistor is equal to the product of voltage and current, so it may be written:

$$W = I\,V = (\frac{V}{C})^{\alpha} \cdot V = \frac{V^{\alpha+1}}{C^{\alpha}} \qquad (10)$$

When the coefficient α = 5, the power dissipated by the varistor is proportional to the 6th power of the voltage. A voltage increase of only 12% will, in this case, double the dissipated power. Consequently it is very important that the applied voltage does not rise above a certain maximum value, as otherwise the permissible rating will be exceeded.

In addition, since varistors have a negative temperature coefficient, at higher dissipation (and accordingly higher temperature) the resistance value will decrease and the dissipated power will increase still more.

Temperature coefficient

In the foregoing formulae no temperature effects have been taken into account. These, however, may not always be neglected, as the C-value has an appreciable negative temperature coefficient. The β-value is practically independent of the temperature. With good approximation it may be written:

$$C_t = C_0\,(1 + at), \qquad (11)$$

in which:

C_t = C-value of the varistor at t °C;
C_0 = C-value of the varistor at 0 °C;
a = temperature coefficient.

For different materials the value of a lies between −0.0010 and −0.0018. Thus, for circuits where the current is constant, the temperature coefficient on voltage lies between −0.10 and −0.18% per degree C.

For circuits where the voltage is constant the temperature coefficient on current lies between +0.4 and +0.8% per degree C, depending on the β-value.

High frequency alternating current

For low frequencies the small capacitance of the varistor does not affect the voltage dependency of the resistance. For high frequencies, however, this parallel capacitance may not be neglected. For low voltages and currents they may even determine the impedance of the varistor. At high voltages, the influence of the capacitance is less serious; because in that case the resistance over which this capacitance is shunted has decreased. In general the effect of the capacitance in h.f. circuits will be an apparent increase of β. Furthermore the voltage/current graph on a logarithmic scale will no longer by a straight line.

A number of curves demonstrating this effect are given in Fig. 3.

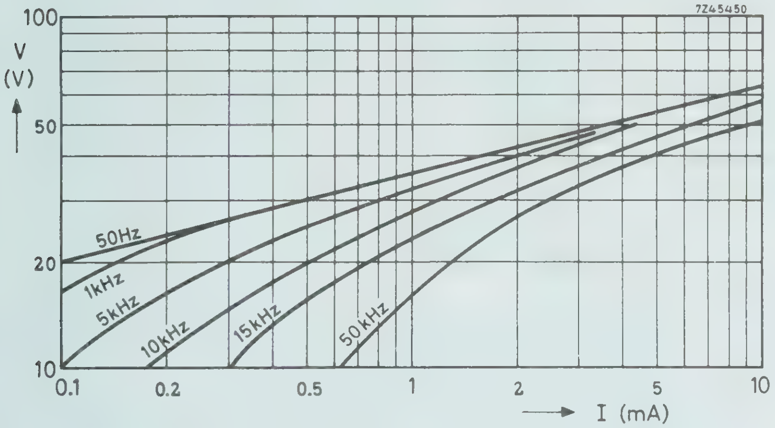


Fig. 3 Voltage/current relation for different frequencies.

PERMISSIBLE DISSIPATION

The temperature which a varistor will reach is determined by the dissipated power, the heat conductivity of the material, the contact with, and the nature of, the surrounding medium and by the ambient temperature. As already explained the dissipated power will increase rapidly with increasing voltage.

The cooling per degree Celsius, though increasing slightly with temperature, depends mainly on the total surface area of the varistor.

For most varistor types the maximum permissible body temperature is 125°C.

ZINC-OXIDE VOLTAGE DEPENDENT RESISTORS

Unlike SiC types, the ZnO varistors are mainly intended for applications requiring intermittent power dissipation, i.e. transient suppression and contact arc prevention. In their transient suppression role, the symmetrical mode of operation allows them to be connected directly across a.c. power lines carrying r.m.s. voltages. They are capable of withstanding voltage or current pulses with a high peak energy level. A typical β for this type of varistor is 0.03. This means that, if the current through the varistor increases by a factor of 10 within the straight-line portion of the characteristic, the voltage across it increases by a factor of 1.07.

A typical V/I characteristic for one of these varistors is shown in Fig. 4. The upward turn of the characteristic (decreasing non-linearity) is due to the increasing influence of the linear series resistance of the component as its non-linear resistance falls to very low values at extreme currents. A good approximation of the relationship between the voltage and the current in the curved portion of the characteristics is given by the expression:

$$V = CI^{\beta} + IR_S,$$

where R_S is the series resistance of the varistor.

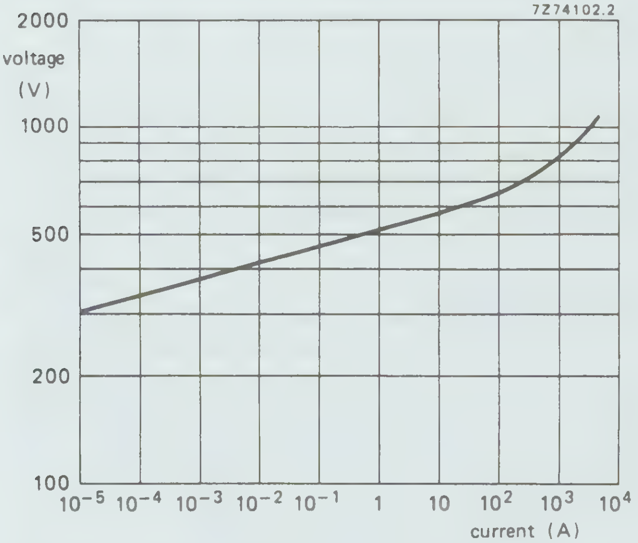


Fig. 4 Typical V/I characteristic of ZnO varistor 2322 595 52516 for 220 V mains supply.

Normal operating conditions of the ZnO varistor

Owing to the extreme nonlinearity of the voltage/current characteristic of ZnO varistors, and the necessity to allow a margin for the extra dissipation during a transient, ensure that the maximum voltage applied across the varistor during normal operation never attains such a value that the specified average dissipation limit of the varistor is approached. This will never be a problem if the varistor is selected according to the figures for max. r.m.s. voltage in the data sheet. The peak value of the sinusoidal voltage applied to the varistor must always be less than the minimum voltage specified at 1 mA. If the applied voltage is other than sinusoidal, the varistor should be selected on the basis of the specified maximum peak working voltage.

HOW TO MEASURE VARISTORS

The following points have to be considered when measuring varistors.

1. Use only d.c. voltage.
2. Keep the measuring time as short as possible. Self-heating effects may influence the measurements due to the negative temperature coefficient of the varistors.
3. When the varistors are specified at a voltage and current which is above the maximum dissipation, pulses should be used. For instance all zinc oxide types, which are for spike/transient suppression are measured under pulse-conditions. These types are measured with a standard pulse current 8/20 μs as defined in IEC 60-2, section 6.
4. The β-value measurement needs some explanation. As mentioned earlier the β-value is not always constant but depends on the voltage and current. The β-values of our discs are measured between 0.3 I and 3 I, where I is the current at which the varistor is specified. For example:

$$\beta = \log \frac{V_2}{V_1}; \text{ with } V_2 = \text{voltage at } 3\,I, \quad V_1 = \text{voltage at } 0{,}3\,I.$$

TOLERANCES

Standard varistors are specified with a certain tolerance on voltage and a spread on β-value. It can be seen in Fig. 5 that due to the spread in β-value the tolerance on voltage may increase at currents other than the specified current at which the varistor is measured.

For some applications, where tolerances have to be kept as low as possible, the varistors are measured at a current or voltage which lies near to its working point in the circuit. For other applications, especially spark suppression, it is often important to specify the varistor at two points: a point at low current or low voltage and a point at high current or high voltage.

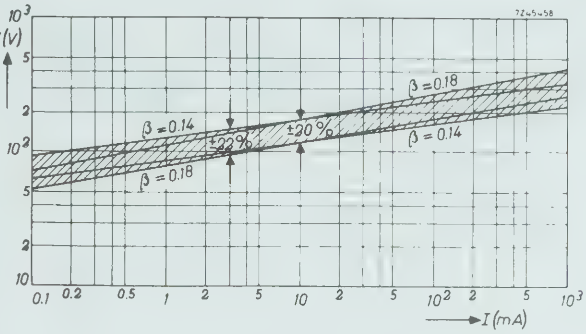


Fig. 5 Spread of voltage/current characteristic due to β-tolerance.

METAL OXIDE VARISTORS

Table 1. Metal Oxide Varistor Performance Characteristics

Maximum Continuous Voltage		Voltage at 1 mA		Part Number *See Table 6	Maximum Clamping Voltage at Cuurent (8 x 20 μS)		Maximum Energy (10 x 1000 μS)	Maximum Non-Repetitive Surge Current (8 x 20 μS)	Typical Capacitance at 1 KHz
V(RMS)	V(DC)	V(MIN)	V(MAX)		V	A	Joules	A	pF
14	18	20	24	2322-592-51406	48	1.0	0.5	100	1300
				2322-593-51406	43	2.5	1.7	250	2800
				2322-594-51406	43	5.0	4.3	500	6000
				2322-595-51406	43	10.0	5.4	1000	15000
				2322-596-51406	43	20.0	16.0	2000	17000
17	22	24	30	2322-592-51706	60	1.0	0.7	100	1050
				2322-593-51706	53	2.5	2.0	250	2000
				2322-594-51706	53	5.0	5.3	500	4000
				2322-595-51706	53	10.0	6.9	1000	10000
				2322-596-51706	50	20.0	17.0	2000	16000
20	26	30	36	2322-592-52006	73	1.0	0.8	100	900
				2322-593-52006	65	2.5	2.5	250	1500
				2322-594-52006	65	5.0	6.5	500	3000
				2322-595-52006	65	10.0	8.8	1000	7500
				2322-596-52006	58	20.0	22.0	2000	15000
25	31	35	43	2322-592-52506	86	1.0	0.9	100	500
				2322-593-52506	77	2.5	3.0	250	1350
				2322-594-52506	77	5.0	7.7	500	2600
				2322-595-52506	77	10.0	9.4	1000	6500
				2322-596-52506	77	20.0	26.0	2000	14000
30	38	42	52	2322-592-53006	96	1.0	1.1	100	700
				2322-593-53006	93	2.5	3.6	250	1600
				2322-594-53006	93	5.0	9.2	500	2700
				2322-595-53006	90	10.0	12.0	1000	6000
				2322-596-53006	93	20.0	30.0	2000	13000
35	45	50	62	2322-592-53506	123	1.0	1.4	100	560
				2322-593-53506	115	2.5	4.4	250	1300
				2322-594-53506	110	5.0	11.0	500	2200
				2322-595-53506	105	10.0	14.0	1000	4800
				2322-596-53506	110	20.0	35.0	2000	11000
40	56	61	75	2322-592-54006	145	1.0	1.6	100	460
				2322-593-54006	135	2.5	5.2	250	1000
				2322-594-54006	130	5.0	13.0	500	1800
				2322-595-54006	130	10.0	17.0	1000	3800
				2322-596-54006	135	20.0	40.0	2000	7000
50	65	74	90	2322-592-55006	145	5.0	2.6	400	370
				2322-593-55006	140	10.0	7.0	1200	900
				2322-594-55006	140	25.0	12.0	2500	1500
				2322-595-55006	140	50.0	21.0	4500	3100
				2322-596-55006	135	100.0	27.0	6500	5500
60	85	90	110	2322-592-56006	165	5.0	2.8	400	290
				2322-593-56006	165	10.0	8.3	1200	700
				2322-594-56006	165	25.0	15.0	2500	1200
				2322-595-56006	165	50.0	24.0	4500	2300
				2322-596-56006	165	100.0	30.0	6500	4800
75	100	108	132	2322-592-57506	190	5.0	3.4	400	240
				2322-593-57506	200	10.0	10.0	1200	530
				2322-594-57506	200	25.0	18.0	2500	1000
				2322-595-57506	200	50.0	29.0	4500	1900
				2322-596-57506	200	100.0	40.0	6500	3800
95	125	135	165	2322-592-59506	230	5.0	4.1	400	180
				2322-593-59506	250	10.0	13.0	1200	450
				2322-594-59506	250	25.0	22.0	2500	800
				2322-595-59506	250	50.0	37.0	4500	1500
				2322-596-59506	250	100.0	50.0	6500	3000
130	170	185	225	2322-592-51316	310	5.0	5.5	400	130
				2322-593-51316	340	10.0	17.0	1200	320
				2322-594-51316	340	25.0	30.0	2500	580
				2322-595-51316	340	50.0	56.0	4500	1050
				2322-596-51316	325	100.0	70.0	6500	3000
140	180	192	242	2322-592-51416	350	5.0	7.1	400	110
				2322-593-51416	370	10.0	20.0	1200	270
				2322-594-51416	370	25.0	36.0	2500	490
				2322-595-51416	370	50.0	59.0	4500	850
				2322-596-51416	370	100.0	75.0	6500	1800
150	200	216	264	2322-592-51516	395	5.0	7.1	400	110
				2322-593-51516	400	10.0	20.0	1200	270
				2322-594-51516	400	25.0	36.0	2500	490
				2322-595-51516	400	50.0	59.0	4500	850
				2322-596-51516	360	100.0	80.0	6500	1600
175	225	247	303	2322-592-51716	410	5.0	7.3	400	90
				2322-593-51716	455	10.0	23.0	1200	230
				2322-594-51716	455	25.0	41.0	2500	430
				2322-595-51716	455	50.0	67.0	4500	750
				2322-596-51716	455	100.0	90.0	6500	1600
230	300	324	396	2322-592-52316	560	5.0	10.0	400	70
				2322-593-52316	600	10.0	30.0	1200	170
				2322-594-52316	600	25.0	54.0	2500	320
				2322-595-52316	600	50.0	88.0	4500	540
				2322-596-52316	595	100.0	120.0	6500	1200
250	320	351	429	2322-592-52516	600	5.0	11.0	400	60
				2322-593-52516	650	10.0	33.0	1200	160
				2322-594-52516	650	25.0	58.0	2500	300
				2322-595-52516	650	50.0	96.0	4500	480
				2322-596-52516	650	100.0	130.0	6500	1000
275	350	387	473	2322-592-52716	695	5.0	12.0	400	55
				2322-593-52716	710	10.0	36.0	1200	140
				2322-594-52716	710	25.0	63.0	2500	270
				2322-595-52716	710	50.0	104.0	4500	440
				2322-596-52716	680	100.0	140.0	6500	900
300	385	423	517	2322-592-53016	750	5.0	13.0	400	50
				2322-593-53016	800	10.0	40.0	1200	130
				2322-594-53016	800	25.0	71.0	2500	240
				2322-595-53016	800	50.0	117.0	4500	400
				2322-596-53016	775	100.0	150.0	6500	900
320	420	462	565	2322-592-53216	800	5.0	15.0	400	45
				2322-593-53216	850	10.0	46.0	1200	115
				2322-594-53216	850	25.0	69.0	2500	210
				2322-595-53216	850	50.0	90.0	4500	380
				2322-596-53216	810	100.0	160.0	6500	750
385	505	558	682	2322-592-53816	1000	5.0	18.0	400	40
				2322-593-53816	1025	10.0	51.0	1200	95
				2322-594-53816	1025	25.0	67.0	2500	180
				2322-595-53816	1025	50.0	110.0	4500	280
				2322-596-53816	950	100.0	155.0	6500	750
420	560	612	748	2322-592-54216	1100	5.0	20.0	400	35
				2322-593-54216	1120	10.0	56.0	1200	85
				2322-594-54216	1120	25.0	73.0	2500	165
				2322-595-54216	1120	50.0	120.0	4500	250
				2322-596-54216	1060	100.0	160.0	6500	600
460	615	675	825	2322-592-54616	1200	5.0	21.0	400	30
				2322-593-54616	1240	10.0	63.0	1200	75
				2322-594-54616	1240	25.0	82.0	2500	150
				2322-595-54616	1240	50.0	135.0	4500	225
				2322-596-54616	1240	100.0	175.0	6500	420
510	670	738	902	2322-594-55116	1335	25.0	89.0	2500	135
				2322-595-55116	1335	50.0	145.0	4500	220
				2322-596-55116	1280	100.0	190.0	6500	500
550	745	819	1001	2322 594-55516	1500	25.0	98.0	2500	120
				2322-595-55516	1500	50.0	160.0	4500	180
				2322-596-55516	1500	100.0	215.0	6500	350

*For composition of the catalogue number, see Table 6

8

Non-Linear Resistors

Electrical characteristics

Varistor characteristics are measured at high currents and high energy levels using an exponentially decaying waveform, as shown in Fig. 6, representative of lightning surges and the discharge of stored energy in reactive circuits. Based on CECC recommendations, the standard waveform used for current and voltage rating measurements has a virtual front duration of 8μs and an impulse duration of 20 μs. It is therefore called the 8/20 μ waveform.

For energy rating measurements, a longer duration waveform (the 10/1000 μs waveform) having exactly the same format as Fig. 6 is used.

Voltage-current characteristics for each varistor series are shown in Figs. 7 to 20.

t_1	t_2
8μs	20μs
10μs	1000μs

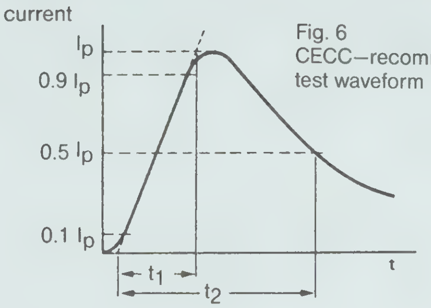


Fig. 6
CECC—recommended test waveform

592 SERIES (A)

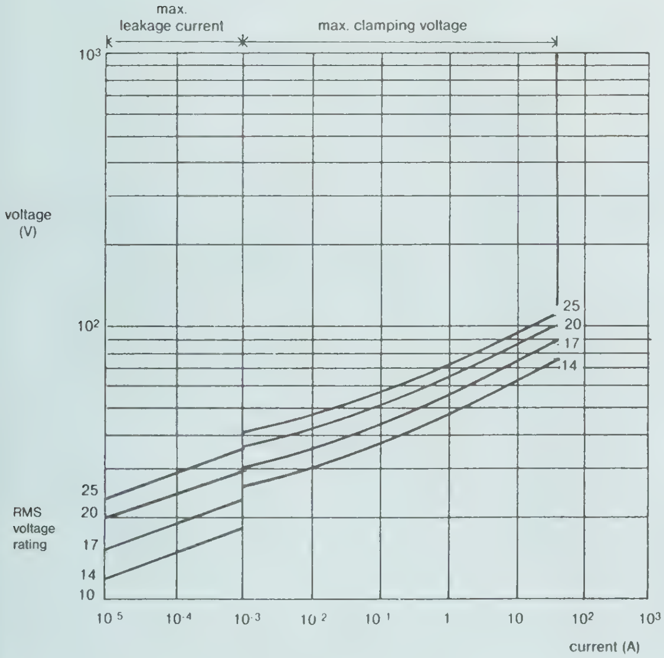


Fig. 7
V-I characteristics, 592 series, 14 to 25 V

592 SERIES (B)

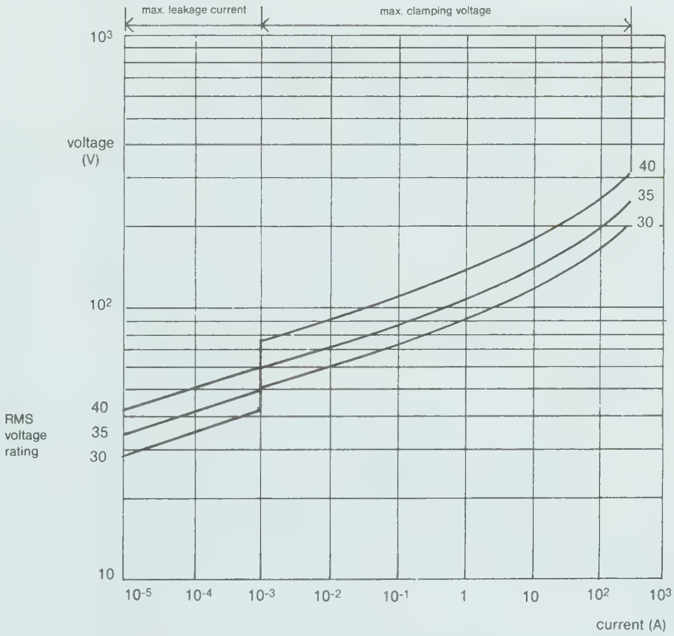


Fig. 8
V-I characteristics, 592 series, 30 to 40 V

8
Non-Linear Resistors

592 SERIES (C)

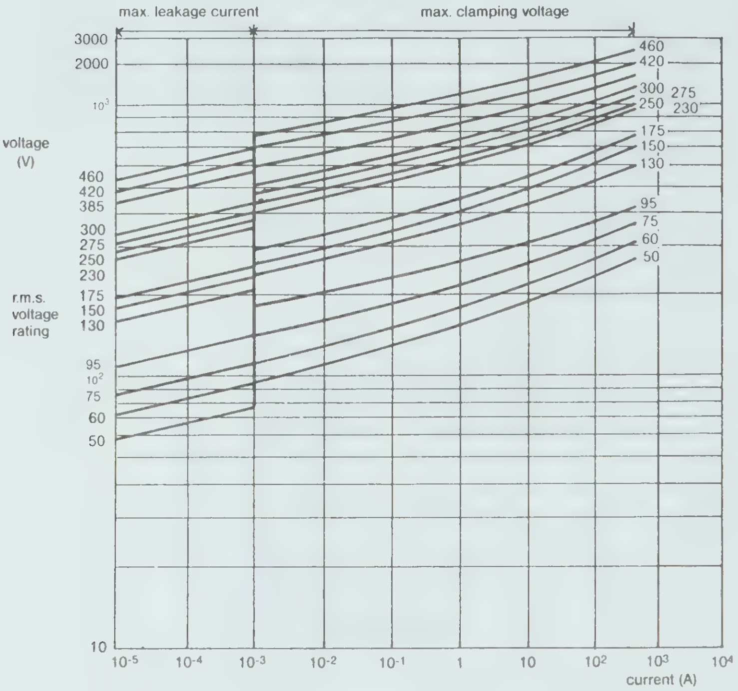


Fig. 9
V-I characteristics, 592 series, 50 to 460 V

593 SERIES (A)

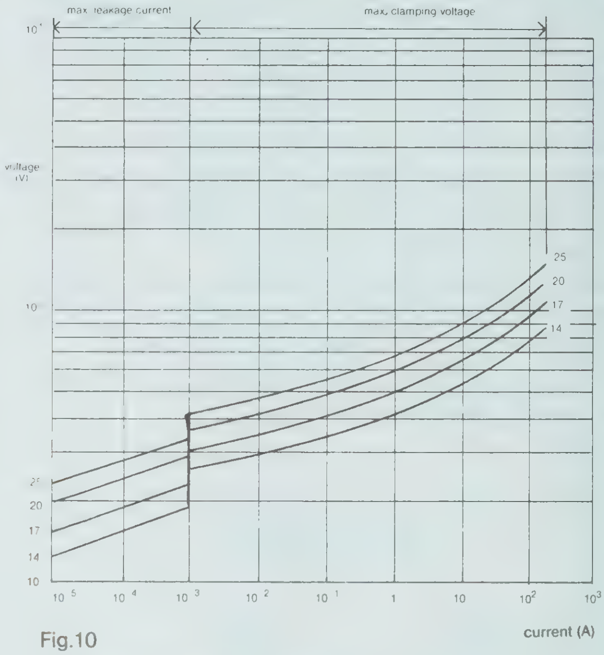


Fig.10
V-I characteristics, 593 series, 14 to 25 V

593 SERIES (B)

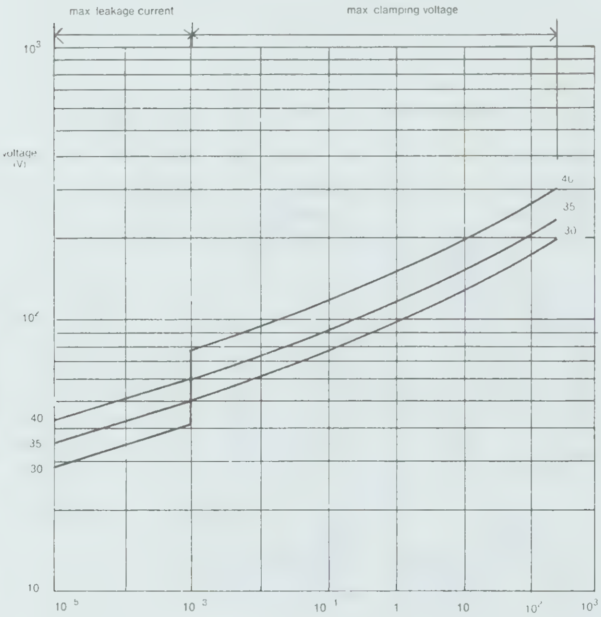


Fig. 11
V-I characteristics, 593 series, 30 to 40 V

593 SERIES (C)

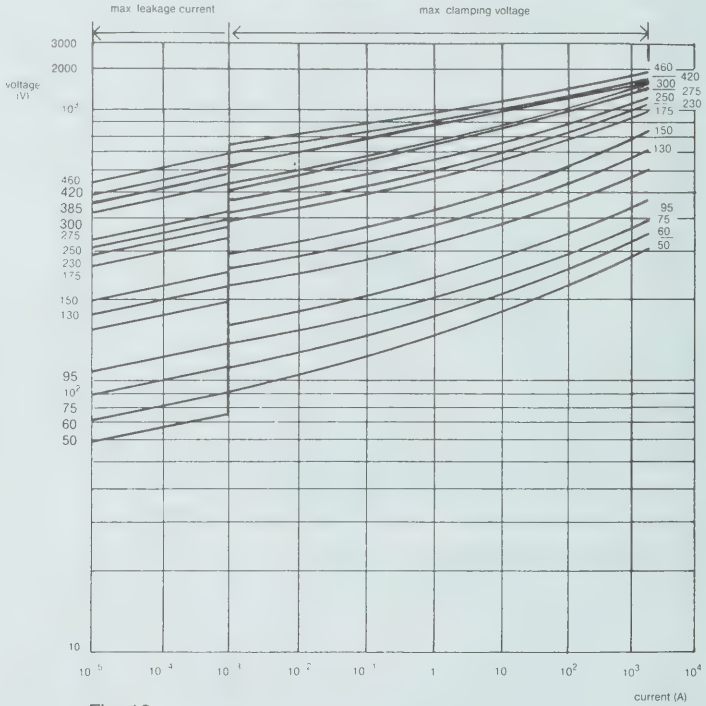


Fig. 12
V-I characteristics, 593 series, 50 to 460 V

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594 SERIES (A)

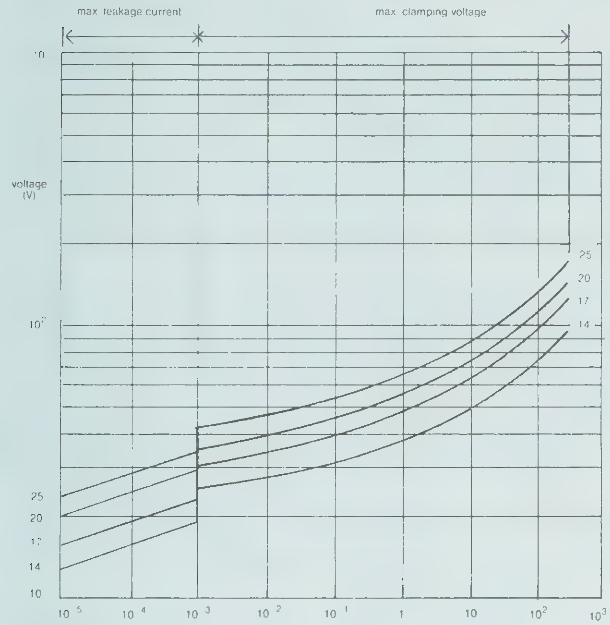


Fig. 13
V-I characteristics, 594 series, 14 to 25 V

594 SERIES (B)

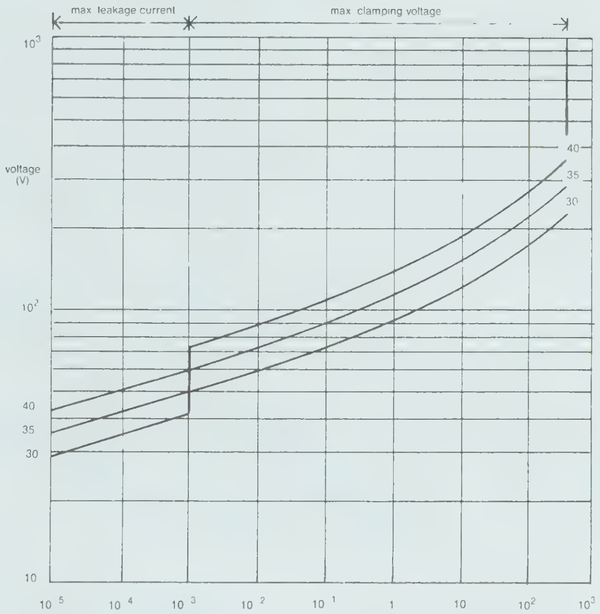


Fig. 14
V-I characteristics, 594 series, 30 to 40 V

594 SERIES (C)

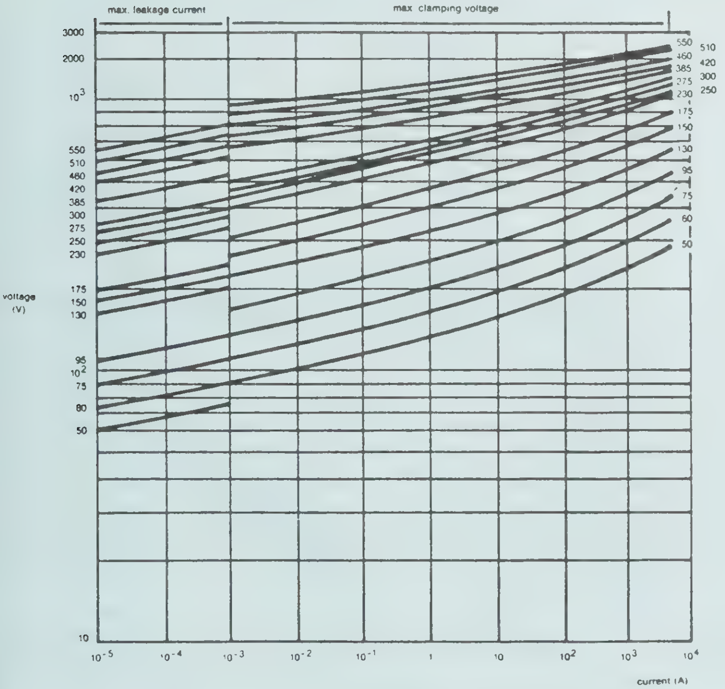


Fig. 15
V-I characteristics, 594 series, 50 to 550 V

595 SERIES (A)

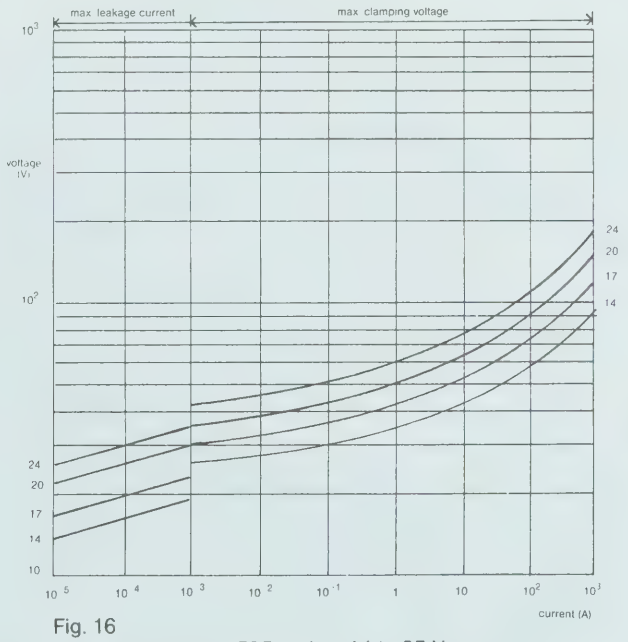


Fig. 16
V-I characteristics, 595 series, 14 to 25 V

METAL OXIDE VARISTORS
Zinc Oxide Disc

595 SERIES (B)

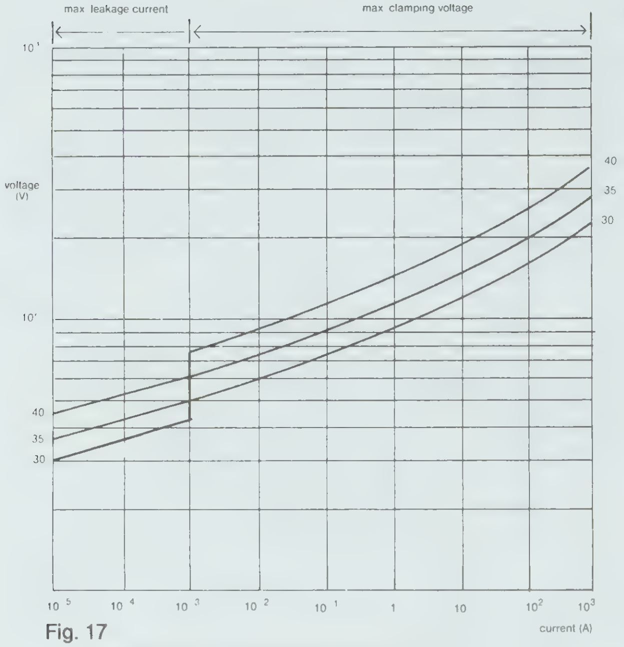


Fig. 17
V-I characteristics, 595 series, 30 to 40 V

595 SERIES (C)

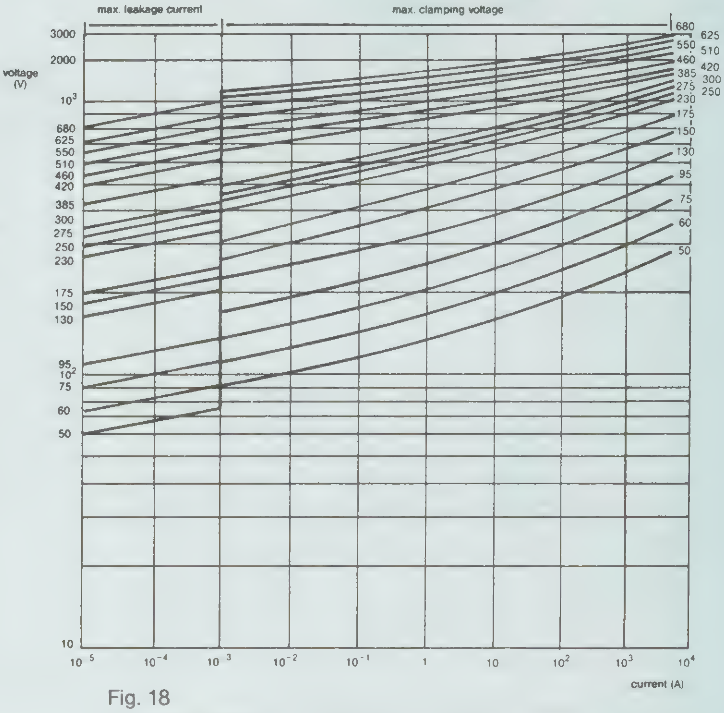


Fig. 18
V-I characteristics, 595 series, 50 to 550 V

596 SERIES (A)

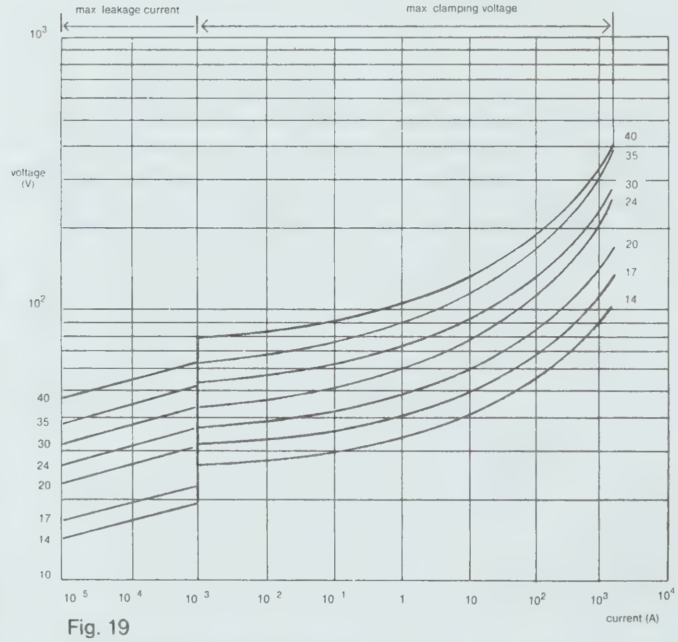


Fig. 19
V-I characteristics, 596 series, 14 to 40 V

596 SERIES (B)

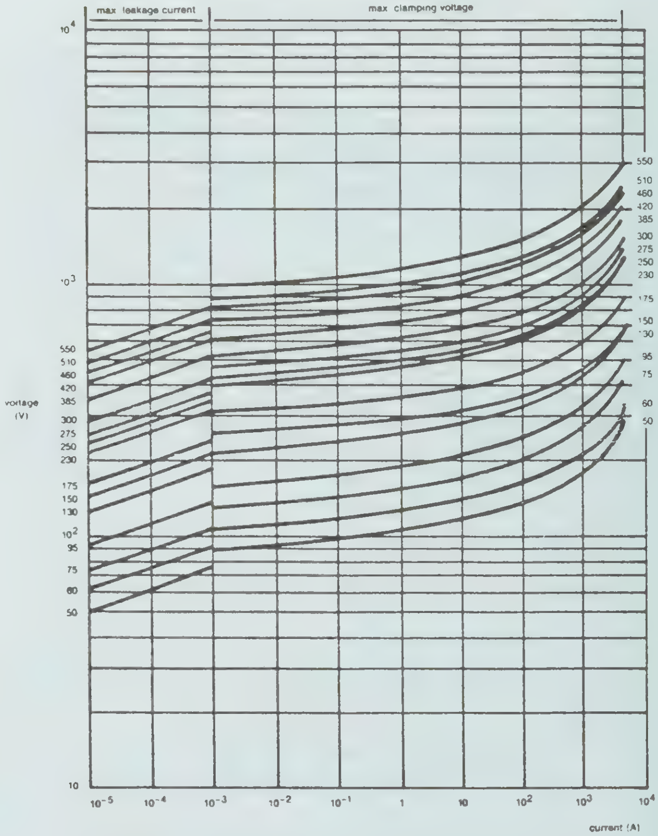
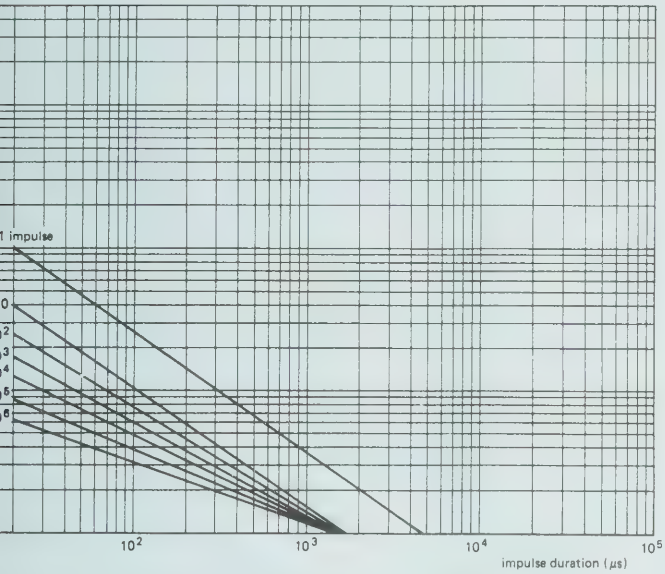


Fig. 20
V-I characteristics, 596 series, 50 to 550 V

8 Non-Linear Resistors

MAX. APPLICABLE TRANSIENT CURRENT AS A FUNCTION OF IMPULSE DURATION

592 SERIES (A)



21 Max. applicable transient current as a function of impulse duration, 592 series, 14 to 40 V

592 SERIES (B)

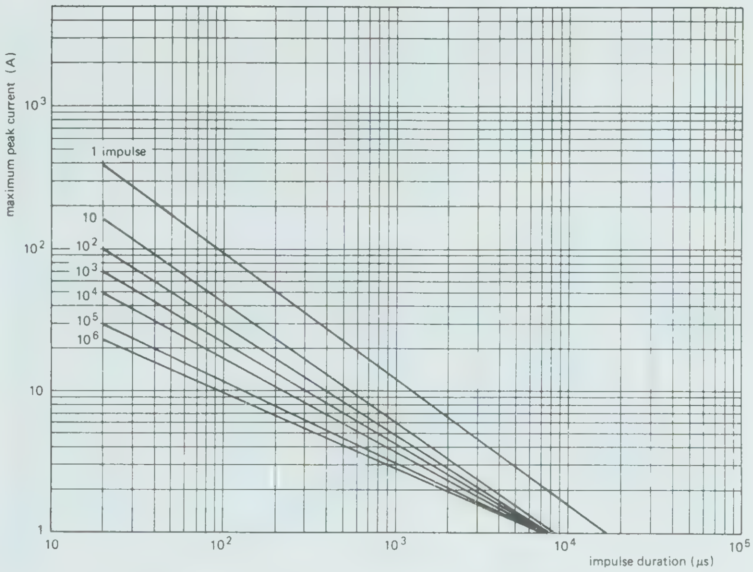
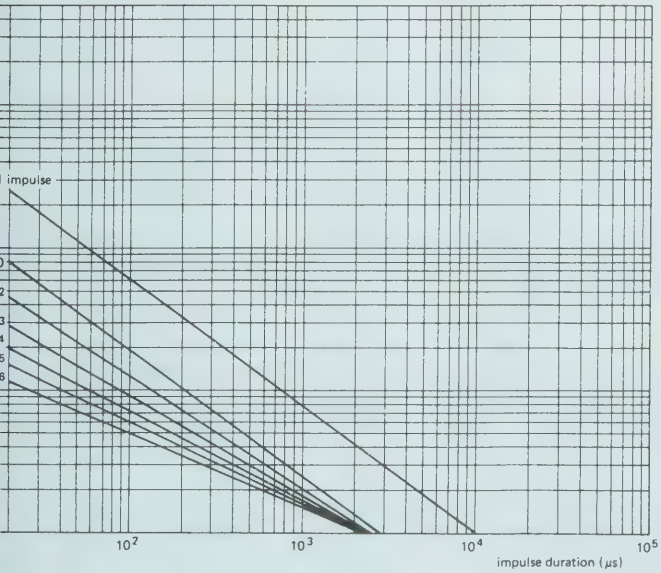


Fig. 22 Max. applicable transient current as a function of impulse duration, 592 series, 50 to 460 V

593 SERIES (A)



23 Max. applicable transient current as a function of impulse duration, 593 series, 14 to 40 V

593 SERIES (B)

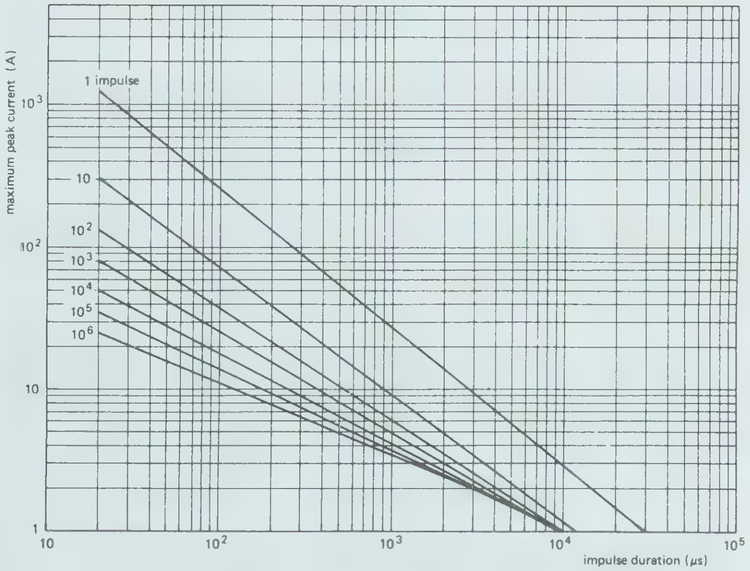


Fig. 24 Max. applicable transient current as a function of impulse duration, 593 series, 50 to 460 V

MAX. APPLICABLE TRANSIENT CURRENT AS A FUNCTION OF IMPULSE DURATION

594 SERIES (A)

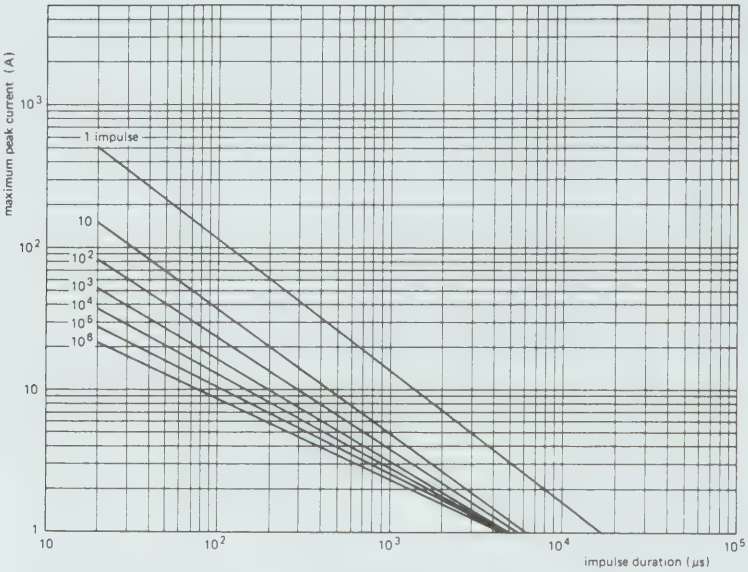


Fig. 25 Max. applicable transient current as a function of impulse duration, 594 series, 14 to 40 V

594 SERIES (B)

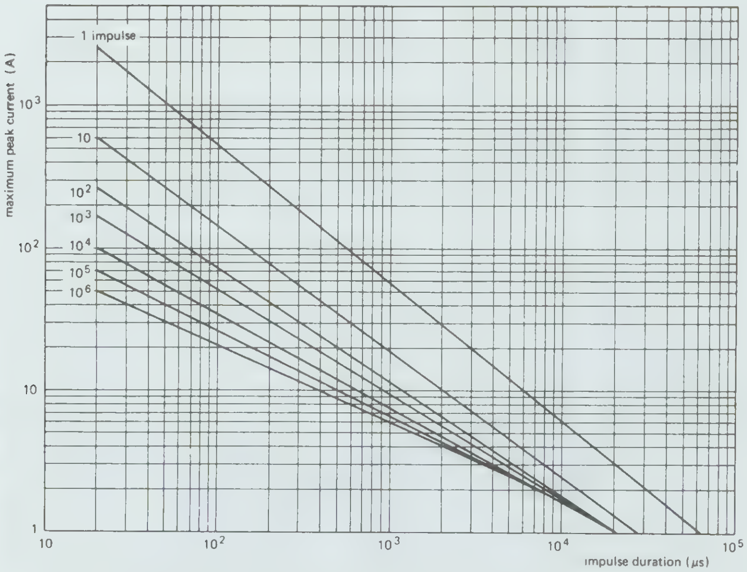


Fig. 26 Max. applicable transient current as a function of impulse duration, 594 series, 50 to 550 V

8 Non-Linear Resistors

MAX. APPLICABLE TRANSIENT CURRENT AS A FUNCTION OF IMPULSE DURATION

595 SERIES (A)

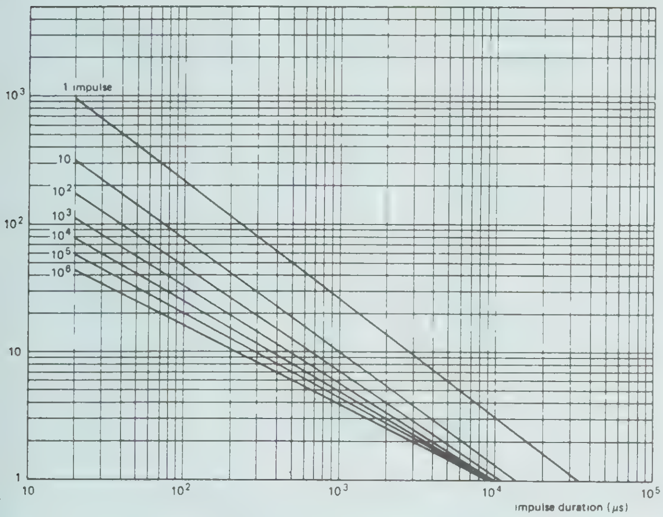


Fig. 27 Max. applicable transient current as a function of impulse duration, 595 series, 14 to 40 V

595 SERIES (B)

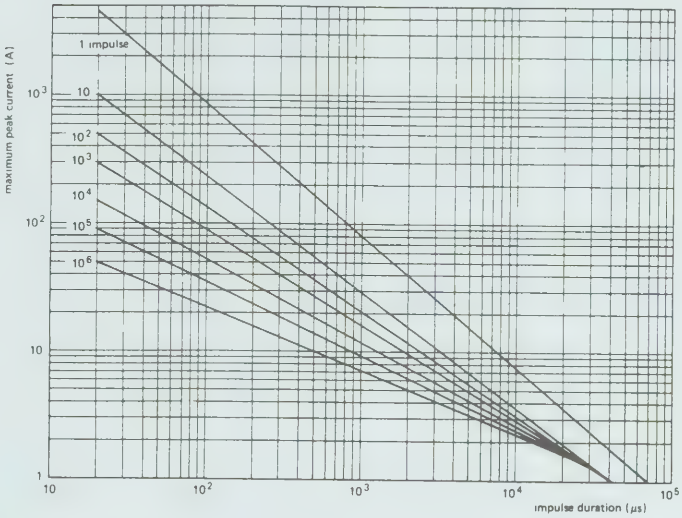


Fig. 28 Max. applicable transient current as a function of impulse duration, 595 series, 50 to 550 V

596 SERIES (A)

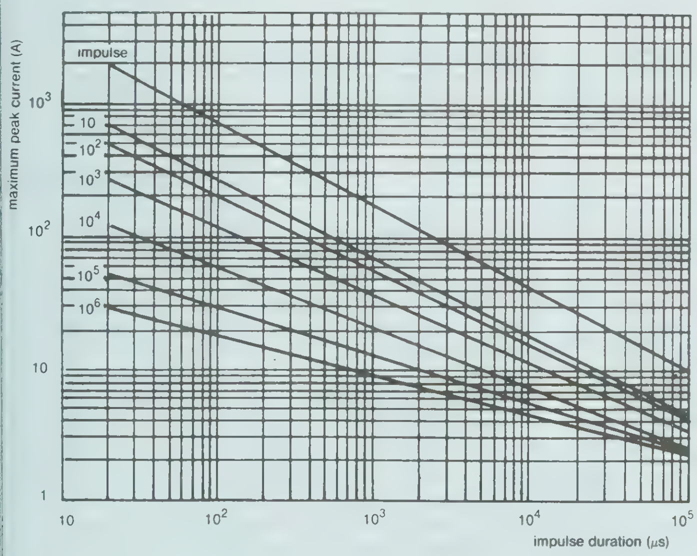


Fig. 29 Max. applicable transient current as a function of impulse duration, 596 series, 14 to 40V

596 SERIES (B)

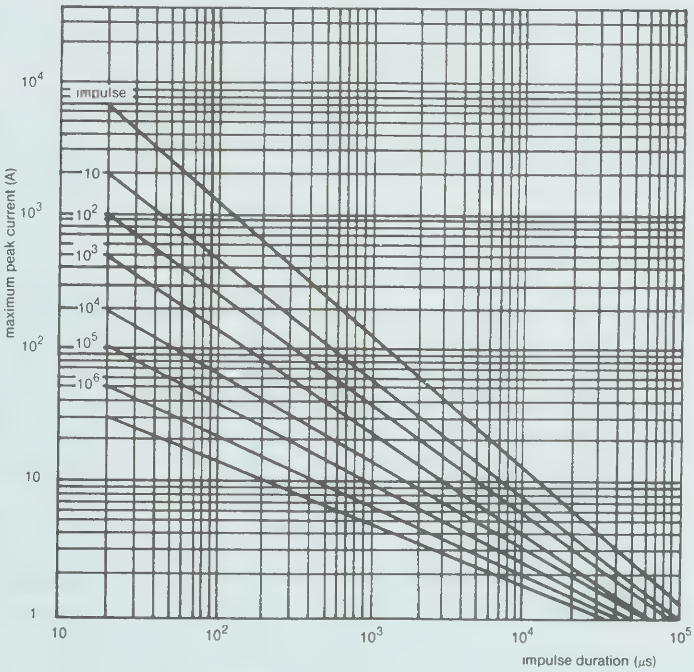


Fig. 30 Max. applicable transient current as a function of impulse duration, 596 series, 50 to 550V

METAL OXIDE VARISTORS

Zinc Oxide Disc

VOLTAGE

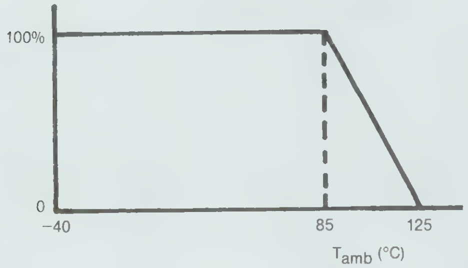


Fig. 31 Derating of max. DC or RMS working voltage with temperature.

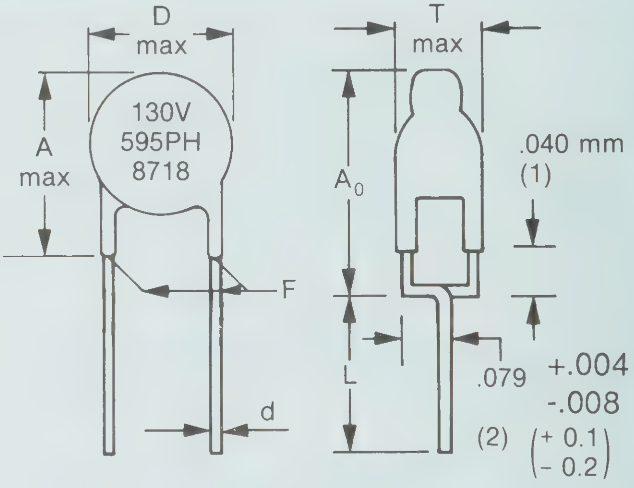


Figure 32B Kinked Lead

MECHANICAL DIMENSIONS:

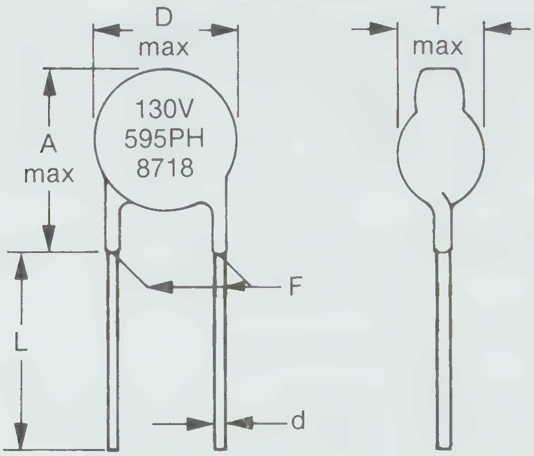


Figure 32A Straight Lead

Table 3 Maximum thickness (T) in inches (mm) from Table 2

RMS VOLTAGE	SERIES 592, 593	SERIES 594, 595, 596
14-95	0.162 (4.1)	0.173 (4.4)
130	0.165 (4.2)	0.181 (4.6)
140-150	0.173 (4.4)	0.189 (4.8)
175	0.181 (4.6)	0.197 (5.0)
230-275	0.193 (4.9)	0.213 (5.4)
300	0.209 (5.3)	0.232 (5.9)
320-385	0.228 (5.8)	0.260 (6.6)
420	0.232 (5.9)	0.260 (6.6)
460	0.236 (6.0)	0.260 (6.6)
510	–	0.272 (6.9)
550	–	0.276 (7.0)

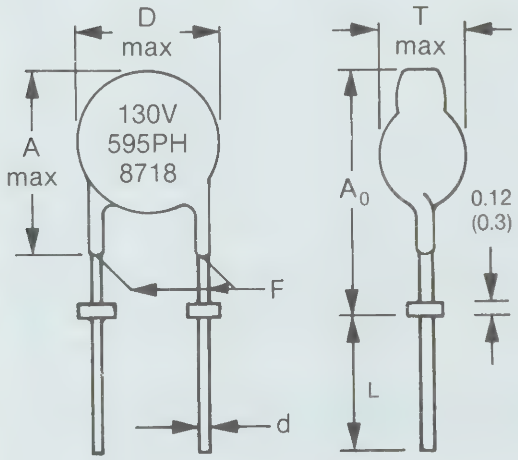


Figure 32C Flanged Lead

Table 2 Dimensions in inches (mm) for Figures 32A, B, C

SERIES	0 (MAX)	T (MAX)	A (MAX)	L (MIN)	D (±10%)	F	A (MAX)
592	0.276 (7)	0.236 (6.0)	0.355 (9)	0.787 (20)	0.024 (0.6)	0.197 +0.315 −0.008 (5) (+0.8) (−0.2)	0.433 (11)
593	0.354 (9)	0.236 (6.0)	0.433 (11)	0.748 (19)	0.024 (0.6)	0.197 +0.315 −0.008 (5) (+0.8) (−0.2)	0.512 (13)
594	0.531 (13.5)	0.276 (7.0)	0.610 (15.5)	0.669 (17)	0.032 (0.8)	0.300 ±0.039 (7.62) (±1)	–
595	0.669 (17)	0.276 (7.0)	0.748 (19)	0.630 (16)	0.032 (0.8)	0.300 ±0.039 (7.62) (±1)	–
596	0.945 (24)	0.276 (7.0)	1.004 (25.5)	1.000 (25.4)	0.032 (0.8)	0.300 ±0.039 (7.62) (±1)	–

Dimension 'T' dependent on RMS Voltage rating (see Table 3)

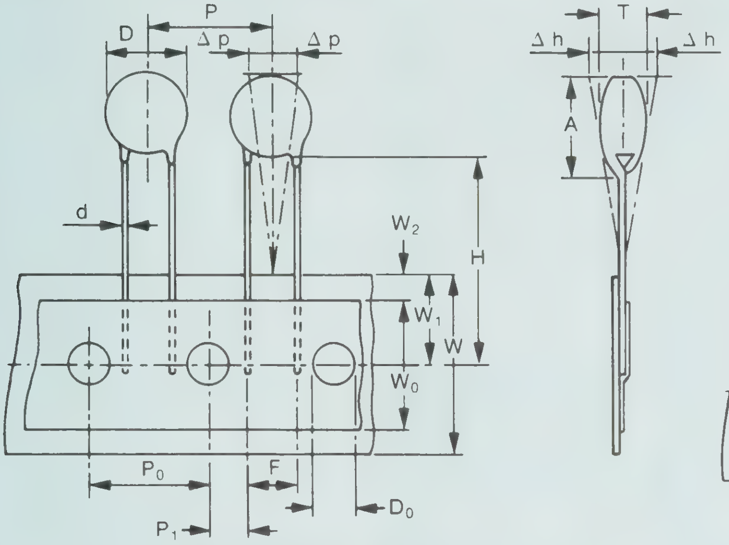


Fig. 33 Straight Lead

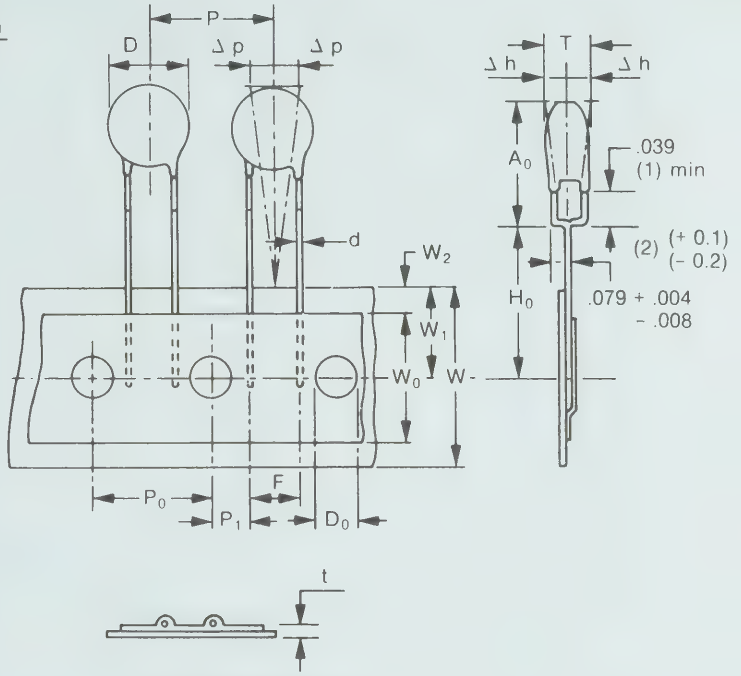


Fig. 33B Kinked Lead

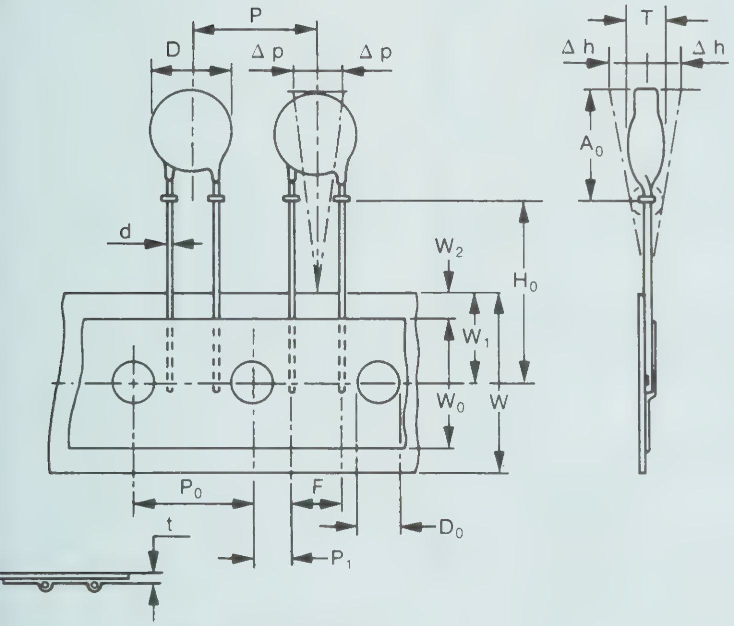


Fig. 33C Flanged Lead

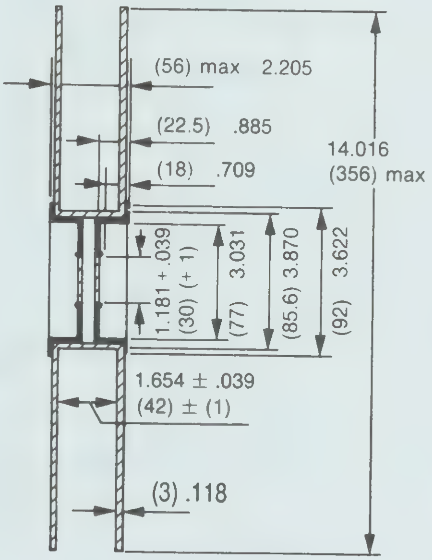


Fig. 33D Reel Dimensions

Table 4. Dimensions in inches (mm) for Figures 33A, B, C

Dimensional Data				
Details	Symbol	Dimensions Nominal	Tolerance	Remarks
Body diameter	D	see table 2		
Total thickness	T	see table 3		
Mounting height	A_0-A	see table 2		
Lead wire diameter	d	see table 2		
Pitch of components	P	(12.7) .500	(±1) ±.040	
Feed hole pitch	P_0	(12.7) .500	(±0.3) ±.012	cumulative pitch error (±1 mm) 20 pitches
Feed hole centre to lead centre	P_1	(3.81) .150	(±0.7) ±.028	guaranteed between component and tape
Component alignment	△p	0	(±1.3) ±.051	
Lead to lead distance	F	see table 2		guaranteed between component and tape
Component alignment	△h	(0) 0	(±2) ±.079	
Tape width	W	(18) .709	(+1/−0.5) +.039/−.020	
Hold down tape width	W_0	.492 (12.5) min.		
Hole position	W_1	(9) .354	(±0.5) ±.079	
Hold down tape position	W_2	.118 (3) max.		
Distance component to tape centre	H	(20) .787	(+2) ±.079	
Lead wire clinch height	H_0	(18.25 or 16) .719 or .630	(±0.5) ±.020	see table 5
Free hole diameter	D_0	(4) .157	(±0.2) ±.008	
Total tape thickness	t	(0.9 max.) .035		with cardboarded tape (0.5 ±0.1) .020±.004
AQL: mechanical Level II			1%	

Table 5. Packaging Configurations

Code number 2322		Packing quntity	Packing	H_o inches (mm) See table 4	Outline
592-	0...6	1500	reel	.630 (16)	fig. 33A
	1...6	1500	reel		fig. 33C
	2...6	1500	reel	.719 (18.25)	fig. 33C
	3...6	1500	reel		fig. 33B
	5...6	500	bulk	–	fig. 32A
	6...6	500	bulk	–	fig. 32B
	7...6	250	bulk		fig. 32C
	8...6	1500	reel	.630 (16)	fig. 33B
593-	0...6	1500	reel	–	fig. 33A
	1...6	1500	reel	.630 (16)	fig. 33C
	2...6	1500	reel	.719 (18.25)	fig. 33C
	3...6	1500	reel		fig. 33B
	5...6	500	bulk	–	fig. 32A
	6...6	500	bulk	–	fig. 32B
	7...6	250	bulk		fig. 32C
	8...6	1500	reel	.630 (16)	fig. 33B
594-	0...6	7501	reel	–	fig. 33A
	5...6	250	bulk		fig. 32A
595-	03006 to 01716	7501	reel	–	fig. 33A
	53006 to 51716	250	bulk		fig. 32A
	02316 to 05516	7501	reel	–	fig. 33A
	52316 to 55516	100	bulk		fig. 32A
596-	5...6	50	bulk	–	fig. 33A

Table 6. Metal Oxide Varistor Part Number Definition

2322
Philips Product

592
Varistor Disc Size
592 = 5 mm
593 = 7 mm
594 = 10 mm
595 = 14 mm
596 = 20 mm

5
***Packaging/Lead Type**
0 = T & R/Straight
1,2 = T & R/Flange †
3,8 = T & R/Kinked †
5 = Bulk/Straight
6 = Bulk/Kinked
7 = Bulk/Flange

* Series 594, 595 are only available as type 0 and 5
*Series 596 only available as type 5
†See Tape and Reel Dimensions

750
Maximum Continuous RMS Voltage

140 = 14V	750 = 75V	301 = 300V
170 = 17V	950 = 95V	321 = 320V
200 = 20V	131 = 130V	381 = 385V
250 = 25V	141 = 140V	421 = 420V
300 = 30V	151 = 150V	461 = 460V
350 = 35V	171 = 175V	511 = 510V
400 = 40V	231 = 230V	551 = 550V
500 = 50V	251 = 250V	
600 = 60V	271 = 275V	

6
Ochre Epoxy Coating
6 = Ochre Epoxy Coating
**7 = Ammo Pack Tape & Ochre Epoxy Coating

**Only available for 592 & 593 Series

Table 7. Test Results

Notes 1. Clause numbers of tests and performance requirements refer to CECC 42000

2. Inspection levels and AQL's are selected from IEC Publication 410.

3. In this table: p = periodicity (in months)
n = sample size
c = acceptance criterion (permitted number of defectives)
D = destructive
ND = non-destructive

4. The varistors shall be mounted by their normal means in such a manner that there shall be no parasitic vibration.

Clause number and test (see note 1)	D or ND	Conditions of test (see note 1)	IL (see note 2)	AQL	Performance requirements (see note 1)
GROUP A INSPECTION (lot-by-lot)					
Sub-Group A1	ND			1.0%	
4.2.1. Visual examination					As in 4.2.1.
4.2.2. Marking					As in 4.2.2.
Sub-Group A2	ND			0.65%	
B2.6 Protection level		At class current given in table 2			As specified in table 2
4.3. Voltage		At 1 mA			Values given in table 2
Sub-Group A3	ND			1.0%	
4.2.3. Dimensions (gauging)		D and T			As specified in tables 1 and 2
GROUP B INSPECTION (lot-by-lot)					
Sub-Group B1	D			2.5%	
4.11. Robustness of terminations		Test Ua and Ub of IEC 68-2-21			
		Visual examination			As in 4.11.6.
		Voltage at 1 mA			Within the values given in table 2
4.10.1. Solderability		Solder bath method: 235±5°C			The terminations shall be uniformly tinned
x.x. Solvent resistance of coating and marking		Visual examination IEC 68-2-45 (1980) Test Xa Solvent: 3.1.1. Temperature: 23±5°C			No visual damage Legible marking
Sub-Group B2	D			1.0%	
4.7. Voltage proof		Method: metal balls (4.7.1.2.) 2500 V			As in 4.7.3.

Clause number and test (see note 1)	D or ND	Conditions of test (see note 1)	Sample size and criterion of acceptability (see note 3) p	n	c	Performance requirements (see note 1)
GROUP C INSPECTION (periodic)						
Sub-Group C1	D		6	13	1	
x.y. Maximum surge current		100 pulses 8/20 μs at 2 per min in one direction				
		Visual examination				No visible damage
		Voltage at 1 mA				△ V/V: ± 10% max.
Sub-Group C2	D		12	13	1	
x.z. Maximum peak current		100 pulses 10/1000 μs in one direction, 1 every 2 min				
		Visual examination				No visible damage
		Voltage at 1 mA				△ V/V: ± 10% max.
Sub-Group C3	D		12	13	1	
		7 specimens				
4.6. Capacitance		f = 1 kHz				
		Signal level 1 V max				As given in table 2
		Zero bias				with ± 50%
4.10.2. Resistance to soldering heat		Method Tb of IEC 68-2-20A				
		Visual examination				As in 4.10.2.4.
		Voltage at 1 mA				△ V/V: ± 5% max.
4.12. Rapid change of temperature		Test Na of IEC 68-2-14				
		Ta: Lower category temp.: −40°C				
		Tb: Upper category temp.: 125°C				
		Visual examination				As in 4.12.4
		Voltage at 1 mA				△ V/V: ± 5% max.
		6 specimens				
4.14. Shock		Pulse shape: half sine				
		Acceleration: 490 m/s²				
		Pulse duration: 11 ms				
		3 x 6 shocks				
		Visual examination				As in 4.14.3
		Voltage at 1 mA				△ V/V: ± 5% max.
		All specimens				
4.17. Climatic sequence						
– Dry heat						
– Damp heat, cyclic, first cycle						
– Cold						
– Damp heat, cyclic, remaining cycles						
– Final measurement		Visual examination				As in 4.16.9.1
		Voltage at 1 mA				△ V/V: ± 5% max.
		Voltage proof				As in 4.7.3.

Clause number and test (see note 1)	D or ND	Conditions of test (see note 1)	Sample size and criterion of acceptability (see note 3) p	n	c	Performance requirements (see note 1)
Sub-Group C4 4.20. Endurance at upper category temperature	D	1000 h at 85°C and at max. r.m.s. voltage Examination at 48 h, 500 h and 1000 h Visual examination Voltage at 1 mA Examination at 1000 h Voltage at class current Voltage proof	12	13	1	As in 4.20.5.1. △ V/V: ± 5% max. 1,1 x the initial limits As in 4.7.3.
GROUP D INSPECTION (periodic) **Sub-Group D1** 4.17. Damp heat, steady state	D	**4 specimens** No applied voltage **Other 4 specimens** Applied voltage: 10% of the max. d.c. voltage Visual examination Voltage at 1 mA Voltage proof	24	8	1	As in 4.17.3.1. △ V/V: ± 5% max. As in 4.7.3.
Sub-Group D2 4.2. Dimensions (detail) 4.5. Temperature coefficient of voltage	ND	At 1 mA	24	8	1	As specified in table 1 and 2 –0.065%/°C
Sub-Group D3 4.18. Inflammability Needle flame test	D	Test IEC 695-2-2 10 s–vertical	24	5	0	5 s max.

NTC THERMISTORS

INTRODUCTION

The word "Thermistor" is a contraction of "thermal resistor," a resistor which changes its resistance with changes in temperature. The NTC Thermistor has a Negative Temperature Coefficient (NTC) and exhibits a decrease in resistance as the temperature of the Thermistor increases.

NTC Thermistors are ceramic semiconductors made by sintering mixtures of heavy metal oxides such as manganese, nickel, cobalt, copper and iron. The metal oxides, their mixtures, and processing are carefully controlled to provide finished Thermistors which are tight tolerance, change resistance vs. temperature in a predictable way, and remain stable for extended periods of time. NTC Thermistors are small, rugged, inexpensive, and accurate. In the temperature range of −55°C. to 300°C. they provide an almost ideal solution to temperature sensing and control, compensation, and inrush current limiting applications.

NTC Thermistors are non-linear devices and the resistance decreases exponentially with increasing temperature. The individual data sheets in the following section show resistance–temperature tables listing the resistance at five degree (C) intervals. It is often necessary for the design engineer to know the resistance at odd temperature points. The resistance at any temperature point over the operating temperature range may be calculated with a high degree of accuracy by using the Steinhart and Hart equation and three resistance-temperature points from the Resistance-Temperature tables.

The Steinhart and Hart equation, an empirical expression, has been determined to be the best mathematical expression for the resistance-temperature relationship of a negative-temperature-coefficient thermistor. It is usually found explicit in T

$$\frac{1}{T} = a + b\,(\mathrm{Ln}\,R) + c\,(\mathrm{Ln}\,R)^3$$

where T is the Kelvin temperature, Ln is the logarithm of R to the base e, and a, b and c are coefficients derived from measurement.

Coefficients a, b and c are found by making measurements of R at three temperatures and solving simultaneously

$$\frac{1}{T_1} = a + b\,(\mathrm{Ln}\,R_1) + c\,(\mathrm{Ln}\,R_1)^3$$

$$\frac{1}{T_2} = a + b\,(\mathrm{Ln}\,R_2) + c\,(\mathrm{Ln}\,R_2)^3$$

$$\frac{1}{T_3} = a + b\,(\mathrm{Ln}\,R_3) + c\,(\mathrm{Ln}\,R_3)^3$$

It is often useful to have this relationship explicit in R. The transformation is developed here.

For any R the equation for T may be written in the form

$$c\,(\mathrm{Ln}\,R_\tau)^3 + b\,(\mathrm{Ln}\,R_\tau) + \left(a - \frac{1}{T_\tau}\right) = 0$$

This cubic has a root A + B = Ln Rt, where

$$A, B = \left\{-\frac{1}{2}\left(\frac{a - \frac{1}{T_\tau}}{c}\right) \pm \left(\frac{1}{4}\left(\frac{a - \frac{1}{T_\tau}}{c}\right)^2 + \frac{1}{27}\left(\frac{b}{c}\right)^3\right)^{\frac{1}{2}}\right\}^{\frac{1}{3}}$$

which is unique (there are two conjugate imaginary roots) provided that

$$\frac{1}{4}\left(\frac{a - \frac{1}{T_\tau}}{c}\right)^2 + \frac{1}{27}\left(\frac{b}{c}\right)^3 > 0$$

Then the Steinhart and Hart equation explicit in R is

$$R = e(\exp)\left\{-\frac{1}{2}\left(\frac{a - \frac{1}{T_\tau}}{c}\right) + \left(\frac{1}{4}\left(\frac{a - \frac{1}{T_\tau}}{c}\right)^2 + \frac{1}{27}\left(\frac{b}{c}\right)^3\right)^{\frac{1}{2}}\right\}^{\frac{1}{3}}$$

$$+ \left\{-\frac{1}{2}\left(\frac{a - \frac{1}{T_\tau}}{c}\right) - \left(\frac{1}{4}\left(\frac{a - \frac{1}{T_\tau}}{c}\right)^2 + \frac{1}{27}\left(\frac{b}{c}\right)^3\right)^{\frac{1}{2}}\right\}^{\frac{1}{3}}$$

where e (exp) has the usual meaning of $e^{f}(A,B)$.

For ease in calculation let

$$\alpha + \frac{a - \frac{1}{T}}{c}, \qquad \beta + \frac{b}{c}$$

and $R = e(\exp)\left\{\left(-\frac{\alpha}{2} + \left(\frac{\alpha^2}{4} + \frac{\beta^3}{27}\right)^{\frac{1}{2}}\right)^{\frac{1}{3}} + \left(-\frac{\alpha}{2} - \left(\frac{\alpha^2}{4} + \frac{\beta^3}{27}\right)^{\frac{1}{2}}\right)^{\frac{1}{3}}\right\}$

The ability to precisely interpolate for a given temperature from measurement at known fixed points is in a large measure dependent on the closeness of those points. Use of fixed points such as H_2O triple point, Hg triple point, gallium melting point and Indium freezing point provide a solid basis for the interpolation.

For practical reasons some of the following tables have small interpolation differences when random values from the tables are used in the above equation particularly over large spans.

NTC THERMISTORS

Typical NTC Thermistor Application Circuits
APPLICATION EXAMPLES

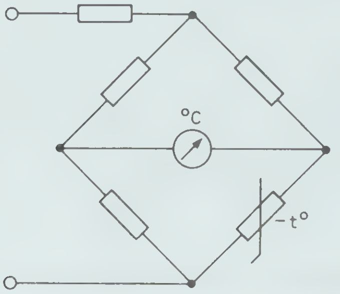


Fig. 1. Temperature measurement in industrial and medical thermometers.

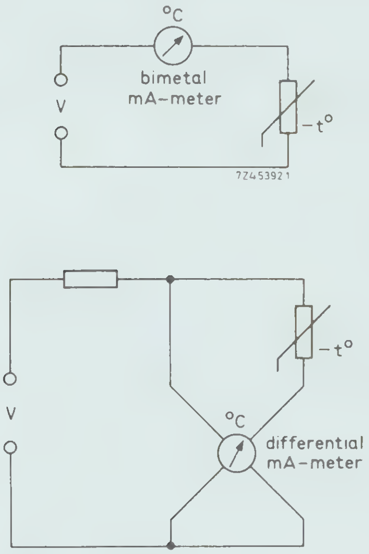


Fig. 2. Temperature measurement in cars. Cooling water measurements with bimetal or differential milliammeters.

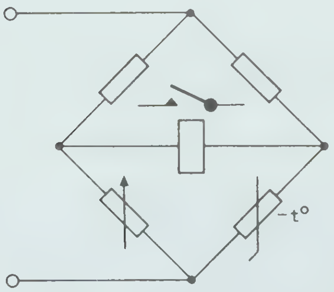


Fig. 3. Temperature control with a bridge incorporating an NTC thermistor and a relay or a static switching device.

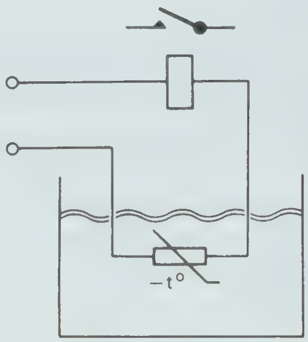


Fig. 4. Liquid level control.

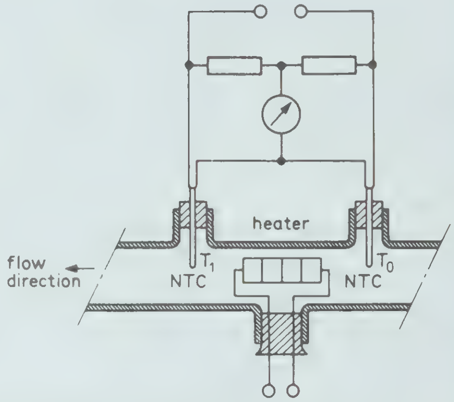


Fig. 5. Flow measurement of liquids. The temperature difference between T_1 and T_0 is a measure for the velocity of the fluid.

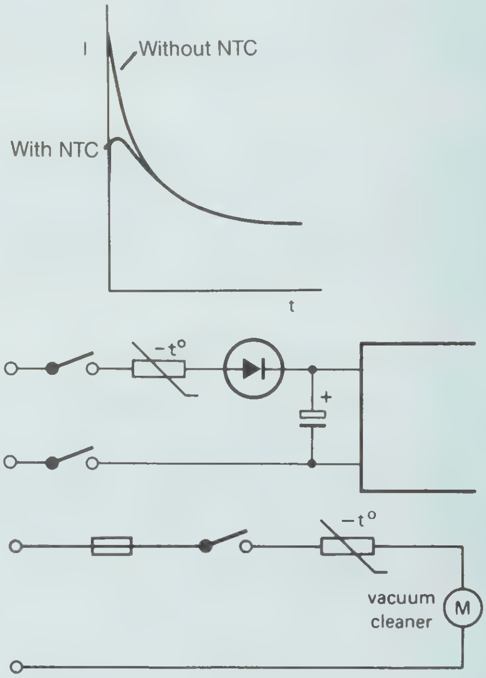
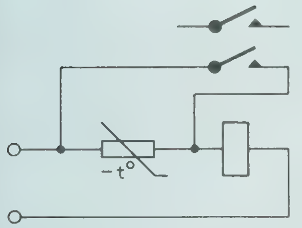


Fig. 6. Inrush current limiter, e.g. for protection of Si-diodes, fuses, switches, and switch mode power supplies.



ig. 7. Delaying action of relays. Due to the thermal inertia of the NTC, it akes some time before the relay is activated. If necessary the NTC can e short-circuited after the relay is activated thus leaving the NTC time or cooling.

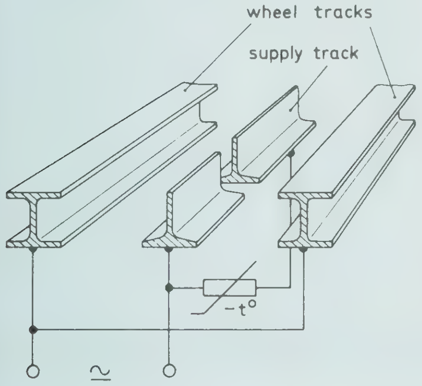


Fig. 8. Model trains. As soon as the train comes on the isolated supply trip, it stops. The NTC heats up and gradually the train starts again.

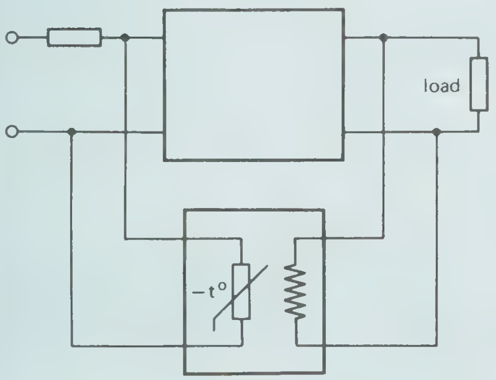


Fig. 9. Gain compensation or gain control with an indirectly heated NTC.

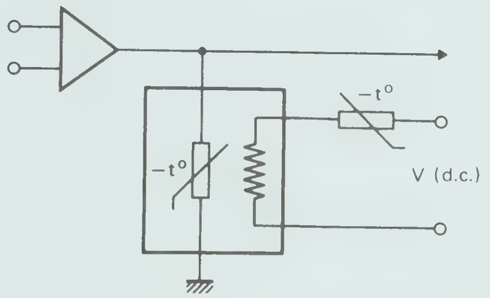


Fig. 10. Compensation for the influence of ambient temperature variations in an h.f. amplifier.

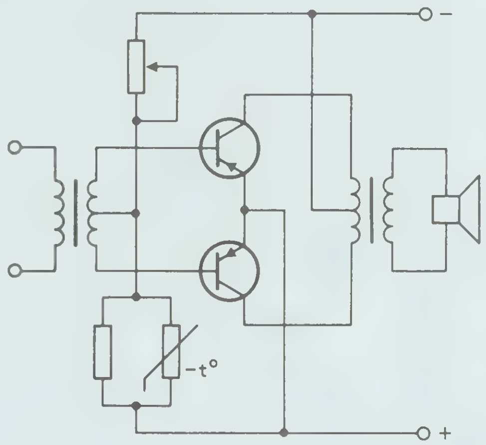


Fig. 11. Temperature compensation in transistor circuits. Push-pull compensation.

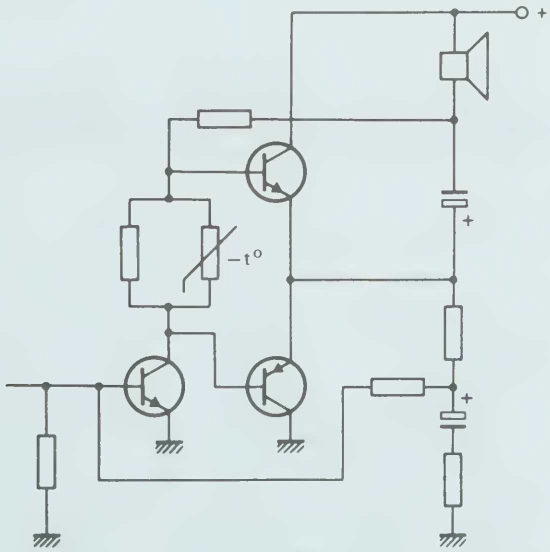


Fig. 12. Transformerless audio output stage with temperature compensation.

NTC THERMISTORS

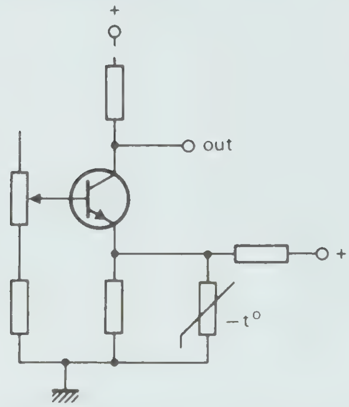


Fig. 13. Stabilization with temperature of an a.g.c. amplifier in a television set.

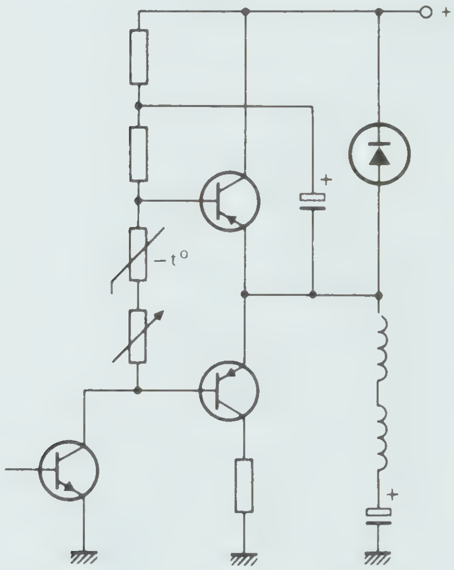


Fig. 14. Compensation of drift in field deflection coils. The influence of the positive temperature coefficient of the copper windings is compensated by means of an NTC thermistor.

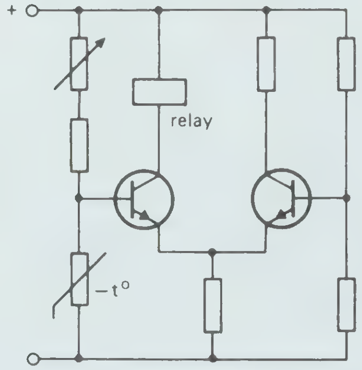


Fig. 15. Simple thermostat.

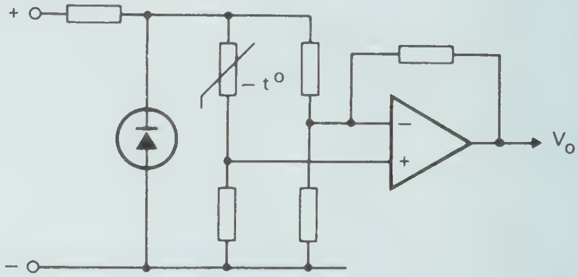


Fig. 16. Temperature sensing bridge with amplifier. The op-amp acts as difference amplifier. The sensitivity can be very high.

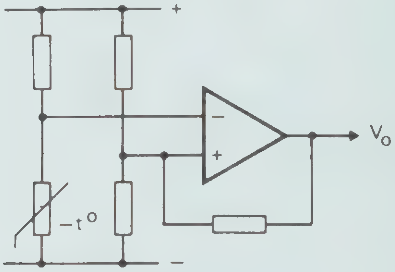


Fig. 17. Basic temperature sensing configuration. The operational amplifier, e.g. type NE532, acts as a Schmitt trigger. The transfer characteristic is given in Fig. 18.

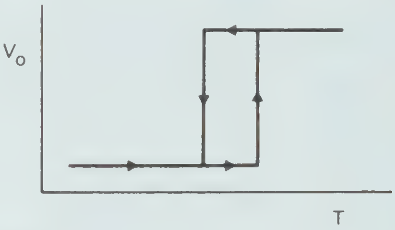


Fig. 18

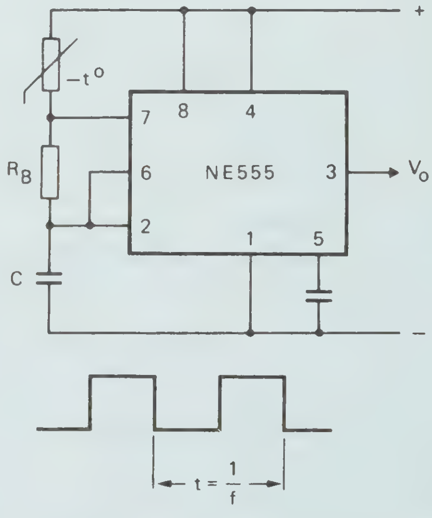


Fig. 19. Temperature controlled oscillator. This is a simple interface circuit for digital and microcomputer-controlled systems. The frequency of the output pulses is proportional to the temperature of the NTC thermistor.

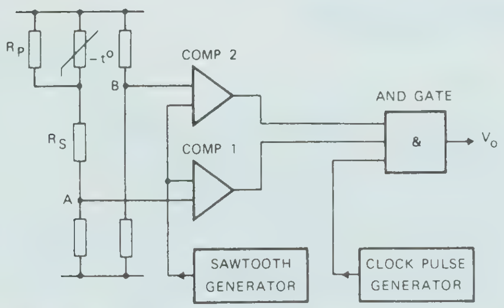


Fig. 20. Temperature sensing bridge with O°C offset and analogue to digital conversion. Due to R_p and R_s the voltage at point A varies linearly with the temperature of the NTC thermistor. The voltage at point B is equal to the voltage at point A when the temperature of the NTC thermistor is 0°C. Both voltages are fed to the comparator circuit. See also Fig. 21.

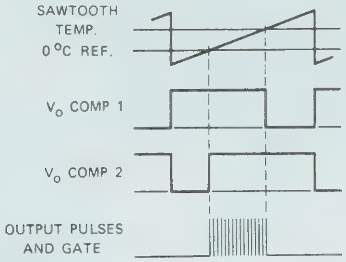


Fig. 21.

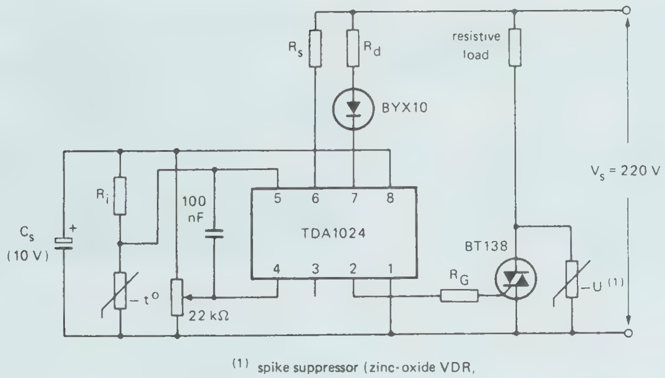
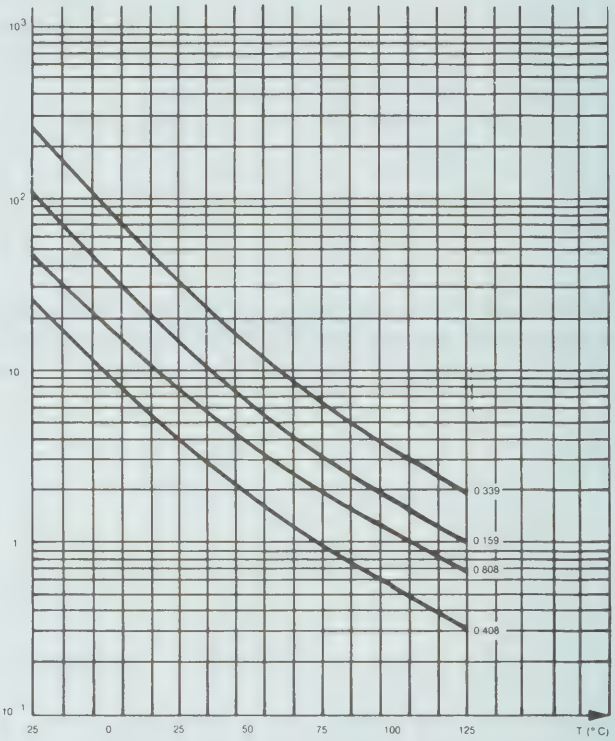


Fig. 22. Thermostat for room temperature control with a 2-point NTC thermistor as the sensing element. The TDA 1024 triggers the triac during the zero crossings of the mains voltage only when the voltage across the NTC thermistor is higher than the voltage at the slider of the 22 kΩ potentiometer. (For complete information see Technical Information 010 and 025).

SERIES 610-0

Disc NTC Thermistor

R_{25} = 4 ohm to 33 ohm 1 Watt



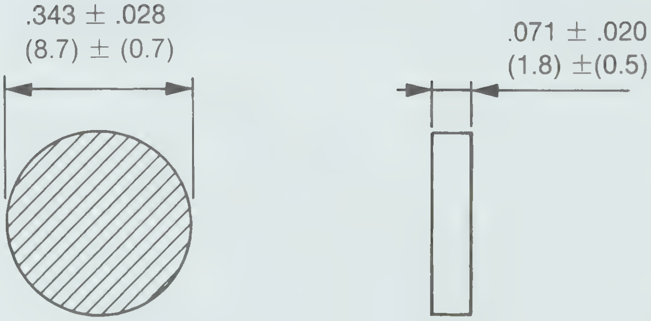
DESCRIPTION

The Series 610-0 NTC Thermistor is a leadless disc intended for general use.

ELECTRICAL SPECIFICATIONS

Dissipation . . . . 1 Watt, maximum
Operating Temperature Range
at zero power . . . . . . −25°C to +125°C
at maximum power . . +55°C max.

R_{25} (ohms)	β25/85 value ±5% (K)	Temperature Coefficient at 25°C (%/°C)	Part Number 10%	Part Number 20%
4	2800	−3.15	2322 610 02408	2322 610 01408
8	2900	−3.25	2322 610 02808	2322 610 01808
15	3125	−3.50	2322 610 02159	2322 610 01159
33	3250	−3.65	2322 610 02339	2322 610 01339



All dimensions in inches (mm)

MECHANICAL DATA

Marking
Resistance value and tolerance legibly printed on one face of the thermistor.

Weight
Approx. .70 grams

Mounting
In any position between clamps or soldering leads on the faces.

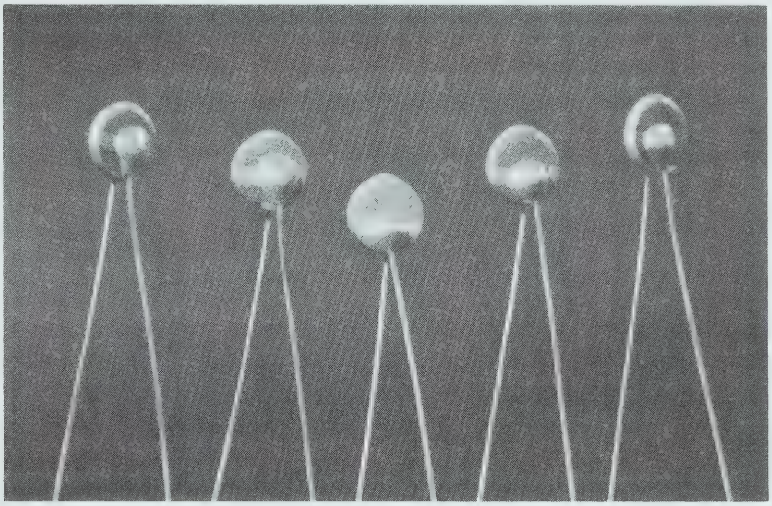
Impact
Free fall: 7.87" (200 mm)

Inflammability
Nonflammable

SERIES 610-1

NTC THERMISTORS

R_{25} = 4 ohm to 33 ohm 1 Watt Maximum



DESCRIPTION

The Series 610-1 NTC Thermistor is a color coded, radial leaded disc intended for general use.

ELECTRICAL SPECIFICATIONS

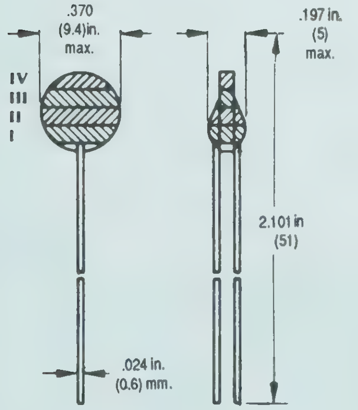
Dissipation . . . . 1 Watt, maximum
Dissipation Factor . . . . approx. 10 mW/°C
Operating Temperature Range
at zero power . . . . . . −25°C to +125°C
at maximum power . . +55°C max.
Thermal
Time Constant . . . . . approx. 60 seconds
Heat Capacity . . . . approx. 0.6 J/°C

R_{25} (ohms)	β25/85 value ±5% (K)	Temperature Coefficient @ 25°C (%/°C)	Part Number 10%	Part Number 20%
4	2800	−3,15	2322 610 12408	2322 610-11408
8	2900	−3,25	2322 610 12808	2322 610-11808
15	3125	−3,40	2322 610 12159	2322 610-11159
33	3250	−3,65	2322 610 12339	2322 610-11339

Color Code			
I	II	III	IV*
yellow	black	gold	silver
grey	black	gold	silver
brown	green	black	silver
orange	orange	black	silver

*10% only
20% has no band

MECHANICAL DATA



All diminsions in inches (mm)

Marking
Color bands

Weight
Approx. 1.1 grams

Mounting
In any position by soldering

Robustness of terminations
Tensile strength: 2.25 lb (ION)
Bending: 1.12 lb (5 N)

Soldering
Solderability: max. 240°C-max. 4s
Resistance to heat: 260±5°C-10±1s

Impact
Free fall: 7.87"(200 mm)

8

Non-Linear Resistors

SERIES 626-1
High Temperature NTC Glass Probes

DESCRIPTION

The Series 626-1 NTC Thermistors are miniature beads encapsulated in a glass probe, able to withstand temperatures as high as 300°C.

ELECTRICAL SPECIFICATIONS

Dissipation . . . . 100 mW maximum
Dissipation Factor . . . . 1.2 mW/°C
Operating Temperature
Range . . . . −55°C to +300°C*
Breakdown Voltage . . . Glass Envelope to leads (VRMS)
*200°C for type with R_{25} < 100k 1500 (min)
Thermal
Time Constant . . . . . 10 seconds in still air
. . . . . 1 second in liquid

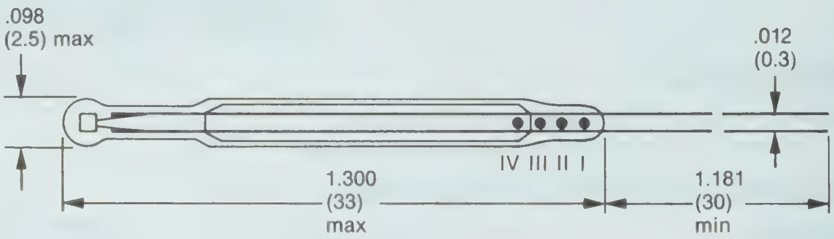
MECHANICAL DATA

Marking
4 color dots

Weight
Approx. 0.3 grams

Mounting
In any position by soldering

Robustness of Terminations
Tensile Strength: .56 lb. (2.5 N)
Bending: .28 lb. (1.25 N)



All dimensions in inches (mm)

Soldering
Solderability: Max. 240°C-Max. 4 sec.
Resistance to Heat: 260°C±5°C 10±1 sec.

Impact
Free fall: 3.94" (100mm)

Non-Flammable

Leads
Dumet (tinned)

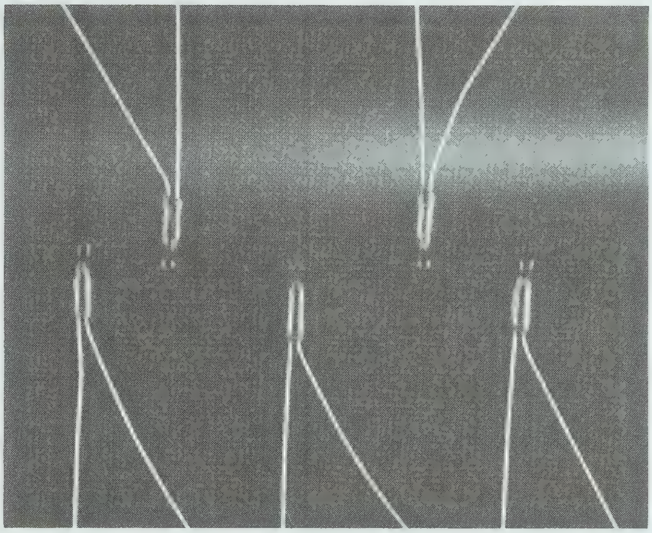
Color Code Chart		
Band I & II Resistance at 25°C	**Band III Multiplier**	**Band IV Tolerance**
0 = Black 5 = Green 1 = Brown 6 = Blue 2 = Red 7 = Violet 3 = Orange 8 = Grey 4 = Yellow 9 = White	10^0 = Black 10^1 = Brown 10^2 = Red 10^3 = Orange 10^4 = Yellow	10% = Silver 5% = Gold

β25/85 ±5%	Temperature Coefficient @ 25°C (%/C)	T_{max}	Part Number 2322 626-1…			Nominal Resistance (At Temperature)					
K	%/K	°C	5%	10%	20%	−25	0	25	85	150	250
2075	−2,3	200	3102	2102	1102	3,868	1,862	1,000	312	126	–
2285	−2,6	200	3222	2222	1222	9,641	4,369	2,200	609	221	–
2485	−2,8	200	3472	2472	1472	23,340	9,838	4,700	1,163	382	–
3750	−4,2	200	3103	2103	1103	110,300	30,555	10,000	1,216	234	–
3560	−4,0	200	3223	2223	1223	223,500	64,180	22,000	2,976	596	–
3750	−4,2	200	3473	2473	1473	526,800	144,300	47,000	5,715	1,065	–
3900	4,4	300	3104	2104	1104	1,223,000	318,500	100,000	11,180	1,990	287
3860	−4,3	300	3224	2224	1224	2,338,000	676,600	220,000	25,150	4,347	629
3950	−4,5	300	3474	2474	1474	5,437,000	1,485,000	470,000	51,070	8,236	1,126
4100	−4,6	300	3105	2105	1105	12,230,000	3,275,000	1,000,000	99,880	15,330	1,869

SERIES 626-2
High Temperature NTC Glass Probes

DESCRIPTION

The Series 626-2 NTC Thermistors are miniature beads encapsulated in a glass probe, able to withstand temperatures as high as 300°C.



ELECTRICAL SPECIFICATIONS

Dissipation . . . . .100 mW maximum
Dissipation factor . . . .0.8 mW/°C
Operating Temperature
Range . . . .−55°C to +300°C*
Breakdown Voltage. . .Glass Envelope to Leads (VRMS) 100 (min)
Thermal
Time Constant . . . . .7.5 seconds in still air
. . . . .0.85 seconds in liquid

*200°C for type with R_{25} < 100k

MECHANICAL DATA

Weight
Approx. 0.33 grams

Mounting
In any position by soldering

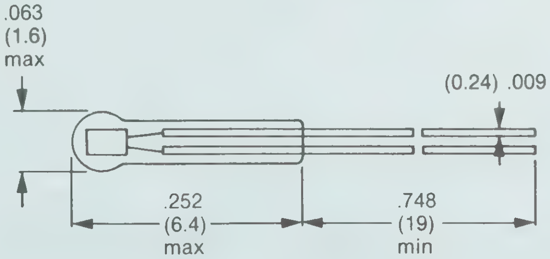
Robustness of Terminations
Tensile Strength: .23 lb. (1 N)

Soldering
Solderability: Max. 240°C-Max. 4 sec.
ResistancetoHeat:260°C±5°C 10±1 sec.

Impact
Free fall: 3.94″ (100mm)

Non-Flammable

Leads
Dumet (tinned)



All dimensions in inches (mm)

β25/85 ±5%	Temperature Coefficient @ 25°C (%/C)	T_{max}	Part Number 2322 626-2...			Nominal Resistance (At Temperature)					
K	%/K	°C	5%	10%	20%	−25	0	25	85	150	250
2075	−2,3	200	3102	2102	1102	3,868	1,862	1,000	312	126	–
2285	−2,6	200	3222	2222	1222	9,641	4,369	2,200	609	221	–
2485	−2,8	200	3472	2472	1472	23,340	9,838	4,700	1,163	382	–
3750	−4,2	200	3103	2103	1103	110,300	30,555	10,000	1,216	234	–
3560	−4,0	200	3223	2223	1223	223,500	64,180	22,000	2,976	596	–
3750	−4,2	200	3473	2473	1473	526,800	144,300	47,000	5,715	1,065	–
3900	−4,4	300	3104	2104	1104	1,223,000	318,500	100,000	11,180	1,990	287
3860	−4,3	300	3224	2224	1224	2,338,000	676,600	220,000	25,150	4,347	629
3950	−4,5	300	3474	2474	1474	5,437,000	1,485,000	470,000	51,070	8,236	1,126
4100	−4,6	300	3105	2105	1105	12,230,000	3,275,000	1,000,000	99,880	15,330	1,869

SERIES 633-0
Miniature NTC Beads

DESCRIPTION
The Series 633-0 NTC Thermistors are miniature beads with ultra-fast response times and axial leads.

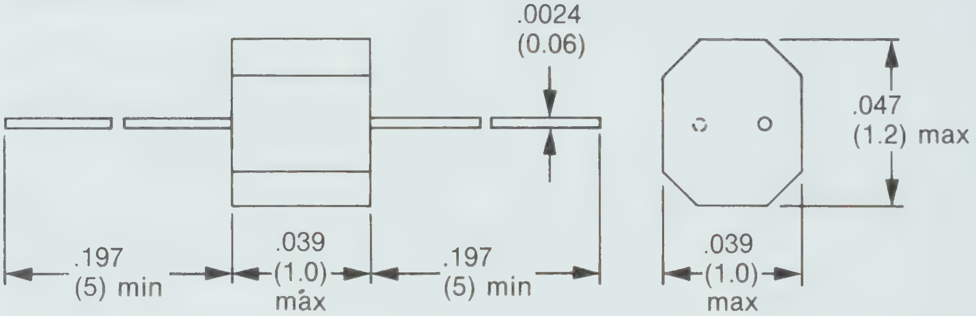
ELECTRICAL SPECIFICATIONS
Dissipation . . . . 25 mW maximum
Dissipation factor . . . . 0.3 mW/°C
Operating Temperature
Range . . . . −55°C to +200°C
Time Constant . . . . 8.5 seconds in still air
. . . . 0.5 seconds in liquid

MECHANICAL DATA
Weight
Approx. 4.24 milligrams

Mounting
In any position by spot welding

Non-Flammable

Leads
Platinum-Iridium



All dimensions in inches (mm)

β25/85 ±5%	Temperature Coefficient @ 25°C (%/C)	T_{max}	Part Number 2322 633-0...		Nominal Resistance (At Temperature)				
K	%/K	°C	5%	10%	−25	0	25	85	150
2075	−2,3	200	3102	2102	3,868	1,862	1,000	312	126
2285	−2,6	200	3222	2222	9,641	4,369	2,200	609	221
2485	−2,8	200	3472	2472	23,340	9,838	4,700	1,163	382
3750	−4,2	200	3103	2103	110,300	30,555	10,000	1,216	234
3560	−4,0	200	3223	2223	223,500	64,180	22,000	2,976	596
3750	−4,2	200	3473	2473	526,800	144,300	47,000	5,715	1,065
3900	−4,4	300	3104	2104	1,223,000	318,500	100,000	11,180	1,990
3860	−4,3	300	3224	2224	2,338,000	676,600	220,000	25,150	4,347
3950	−4,5	300	3474	2474	5,437,000	1,485,000	470,000	51,070	8,236
4100	−4,6	300	3105	2105	12,230,000	3,275,000	1,000,000	99,880	15,330

SERIES 633-1
Miniature NTC Beads

DESCRIPTION
The Series 633-1 NTC Thermistors are miniature beads with ultra-fast response times and radial leads.

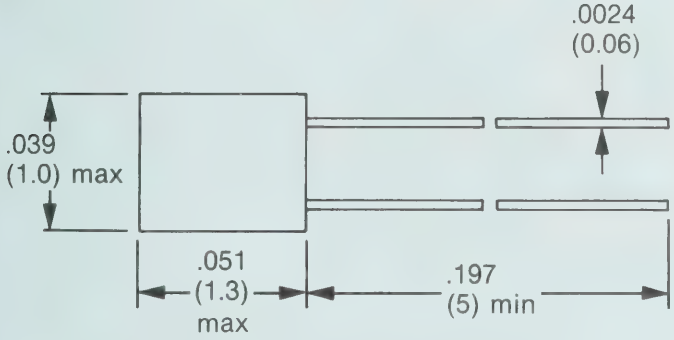
ELECTRICAL SPECIFICATIONS
Dissipation . . . . 25 mW maximum
Dissipation factor . . . . 0.3 mW/°C
Operating Temperature
Range . . . . −55°C to +200°C
Thermal
Time Constant . . . . . 0.5 seconds in still air
. . . . . 0.5 seconds in liquid

MECHANICAL DATA
Weight
Approx. 4.24 milligrams

Mounting
In any position by spot welding

Non-Flammable

Leads
Platinum-Iridium



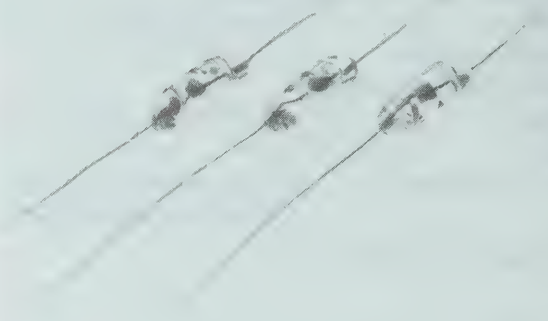
All dimensions in inches (mm)

β25/85 ±5%	Temperature Coefficient @ 25°C (%/C)	T_{max}	Part Number 2322 633-1...		Nominal Resistance (At Temperature)				
K	%/K	°C	5%	10%	−25	0	25	85	150
2075	−2,3	200	3102	2102	3,868	1,862	1,000	312	126
2285	−2,6	200	3222	2222	9,641	4,369	2,200	609	221
2485	−2,8	200	3472	2472	23,340	9,838	4,700	1,163	382
3750	−4,2	200	3103	2103	110,300	30,555	10,000	1,216	234
3560	−4,0	200	3223	2223	223,500	64,180	22,000	2,976	596
3750	−4,2	200	3473	2473	526,800	144,300	47,000	5,715	1,065
3900	−4,4	300	3104	2104	1,223,000	318,500	100,000	11,180	1,990
3860	−4,3	300	3224	2224	2,338,000	676,600	220,000	25,150	4,347
3950	−4,5	300	3474	2474	5,437,000	1,485,000	470,000	51,070	8,236
4100	−4,6	300	3105	2105	12,230,000	3,275,000	1,000,000	99,880	15,330

SERIES 633-2
High Temperature NTC Glass Probes

DESCRIPTION

The Series 633-2 NTC Thermistors are miniature beads encapsulated in a glass probe, able to withstand temperatures as high as 200°C.



ELECTRICAL SPECIFICATIONS

Dissipation . . . . 60 mW maximum
Dissipation factor . . . . 0.5 mW/°C
Operating Temperature Range . . . . −55°C to +200°C
Breakdown Voltage . . . Glass Envelope to Leads (VRMS) 1500 (min)
Thermal Time Constant . . . . . 6.0 seconds in still air
. . . . . 0.6 seconds in liquid

MECHANICAL DATA

Marking
4 color dots

Weight
Approx. 0.1 grams

Mounting
In any position by soldering

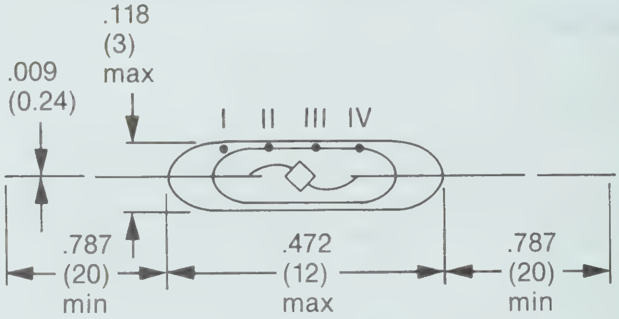
Robustness of Terminations
Tensile Strength: .225 lb. (1 N)
Bending: .113 lb. (0.5 N)
Torsion: 3 times

Soldering
Solderability: Max. 240°C-Max. 4 sec.
Resistance to Heat: 260°C±5°C 10±1 sec.

Impact
Free fall: 3.94" (100mm)

Non-Flammable

Leads
Domet (tinned)



All dimensions in inches (mm)

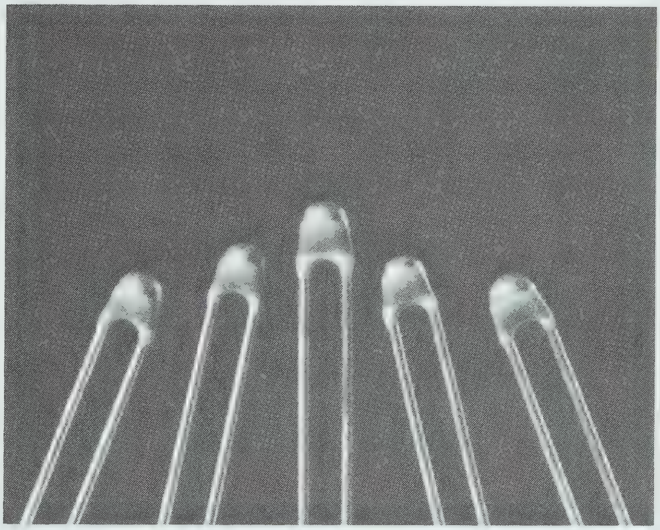
Color Code Chart		
Band I & II Resistance at 25°C	**Band III Multiplier**	**Band IV Tolerance**
0 = Black 5 = Green 1 = Brown 6 = Blue 2 = Red 7 = Violet 3 = Orange 8 = Grey 4 = Yellow 9 = White	10^0 = Black 10^1 = Brown 10^2 = Red 10^3 = Orange 10^4 = Yellow	10% = Silver 5% = Gold

β25/85 ± 5%	Temperature Coefficient @ 25°C (%/C)	T_{max}	Part Number 2322 626-2...			Nominal Resistance (At Temperature)					
K	%/K	°C	5%	10%	20%	−25	0	25	85	150	250
2075	−2,3	200	3102	2102	1102	3,868	1,862	1,000	312	126	–
2285	−2,6	200	3222	2222	1222	9,641	4,369	2,200	609	221	–
2485	2,8	200	3472	2472	1472	23,340	9,838	4,700	1,163	382	–
3750	4,2	200	3103	2103	1103	110,300	30,555	10,000	1,216	234	–
3560	4,0	200	3223	2223	1223	223,500	64,180	22,000	2,976	596	–
3750	4,2	200	3473	2473	1473	526,800	144,300	47,000	5,715	1,065	–
3900	-4,4	300	3104	2104	1104	1,223,000	318,500	100,000	11,180	1,990	287
3860	−4,3	300	3224	2224	1224	2,338,000	676,600	220,000	25,150	4,347	629
3950	4,5	300	3474	2474	1474	5,437,000	1,485,000	470,000	51,070	8,236	1,126
4100	-4,6	300	3105	2105	1105	12,230,000	3,275,000	1,000,000	99,880	15,330	1,869

SERIES 640-6
NTC Thermistors For Temperature Measurement and Compensation

DESCRIPTION

The Series 640-6 NTC Thermistors are radial leaded, color coded devices intended for general use and applications. Available in 10%, 5% and 3%.



ELECTRICAL SPECIFICATIONS

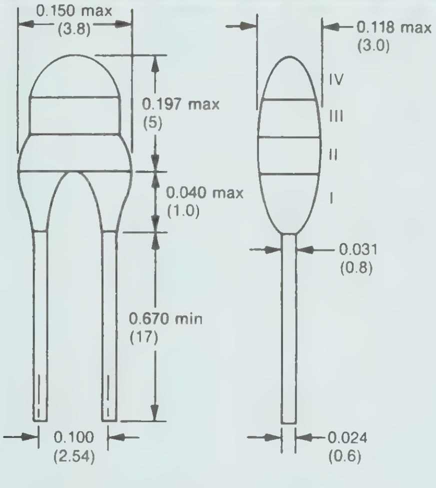
Dissipation .... 250 mW, maximum
Dissipation factor .... 7 mW/°C
Operating Temperature Range .... −40°C to +150°C
Thermal Time Constant ..... Approx. 11 seconds in still air
..... Approx. 1.2 seconds in liquid

MECHANICAL DATA

Marking
4 color bands

Weight
Approx. 0.22 grams

Mounting
In any position by soldering



All dimensions in inches (mm)

Color Code Chart		
Band I & II Resistance at 25°C	**Band III Multiplier**	**Band IV Tolerance**
0 = Black 5 = Green	10^0 = Black	
1 = Brown 6 = Blue	10^1 = Brown	
2 = Red 7 = Violet	10^2 = Red	10% = Silver
3 = Orange 8 = Grey	10^3 = Orange	5% = Gold
4 = Yellow 9 = White	10^4 = Yellow	3% = Gold

Resistance at 25°C	Part Number (By Tolerance) ±10%	±5%	±3%	β25/85	Stability (%) β Tolerance (25°C) (9%)	Tc (%/°C) (25°C)	T_C1000 Hrs 125°C
2.7K	2322-640-62272	2322-640-63272	2322-640-66272	3977	0.75	−4.37	1.00
3.3K	2322-640-62332	2332-640-63332	2322-640-66332	3977	0.75	−4.37	1.00
4.7K	2322-640-62472	2322-640-63472	2322-640-66472	3977	0.75	−4.37	1.00
6.8K	2322-640-62682	2322-640-63682	2322-640-66682	3977	0.75	−4.37	1.00
10.0K	2322-640-62103	2322-640-63103	2322-640-66103	3977	0.75	−4.37	1.00
12.0K	2322-640-62123	2322-640-63123	2322-640-66123	3740	3.00	−4.10	3.00
15.0K	2322-640-62153	2322-640-63153	2322-640-66153	3740	3.00	−4.10	3.00
22.0K	2322-640-62223	2322-640-63223	2322-640-66223	3740	3.00	−4.10	3.00
33.0K	2322-640-62333	2322-640-63333	2322-640-66333	4100	2.00	−4.48	2.00
47.0K	2322-640-62473	2322-640-63473	2322-640-66473	4100	2.00	−4.48	2.00
68.0K	2322-640-62683	2322-640-63683	2322-640-66683	4190	2.00	−4.57	2.00
100.0K	2322-640-62104	2322-640-63104	2322-640-66104	4190	2.00	−4.57	2.00
150.0K	2322-640-62154	2322-640-63154	2322-640-66154	4370	3.00	−4.75	3.00
220.0K	2322-640-62224	2322-640-66224	2322-640-66224	4370	3.00	−4.75	3.00
330.0K	2322-640-62334	2322-640-63334	2322-640-66334	4570	3.00	−4.95	3.00
470.0K	2322-640-62474	2322-640-63474	2322-640-66474	4570	3.00	−4.95	3.00

SERIES 640-6

Temperature	Ratio R_T/R_{25}	Resistance Deviation due to β Tolerance	Temperature Coefficient	Resistance (kohm) for types 2322 640				
°C		%	%/°C	6.272	6.332	6.472	6.682	6.103
−40	32.84	2.64	6.57	88.67	108.4	154.3	223.3	328.4
−35	23.77	2.40	6.36	64.18	78.44	111.7	161.6	237.7
−30	17.39	2.16	6.15	46.95	57.39	81.72	118.3	173.9
−25	12.85	1.93	5.95	34.70	42.41	60.40	87.38	128.5
−20	9.589	1.71	5.76	25.89	31.64	45.07	65.21	95.89
−15	7.223	1.49	5.58	19.50	23.84	33.95	49.12	72.23
−10	5.489	1.29	5.40	14.82	18.11	25.80	37.33	54.89
−5	4.207	1.08	5. 24	11.36	13.88	19.77	28.61	42.07
0	3.251	0.89	5.08	8.778	10.73	15.28	22.11	32.51
5	2.531	0.70	4.92	6.834	8.352	11.90	17.21	25.31
10	1.986	0.52	4.78	5.362	6.554	9.334	13.50	19.86
15	1.569	0.34	4.64	4.236	5.178	7.374	10.67	15.69
20	1.249	0.17	4.50	3.372	4.122	5.870	8.493	12.49
25	1.000	0.00	4.37	2.700	3.300	4.700	6.800	10.00
30	0.8060	0.16	4.25	2.176	2.660	3.788	5.481	8.060
35	0.6536	0.32	4.13	1.765	2.157	3.072	4.444	6.536
40	0.5331	0.47	4.02	1.439	1.759	2.506	3.625	5.331
45	0.4372	0.62	3.91	1.181	1.443	2.055	2.973	4.373
50	0.3606	0.77	3.80	0.9736	1.190	1.695	2.452	3.606
55	0.2989	0.91	3.70	0.8070	0.9864	1.405	2.033	2.989
60	0.2490	1.05	3.60	0.6723	0.8217	1.170	1.693	2.490
65	0.2085	1.18	3.51	0.5630	0.6881	0.9800	1.418	2.085
70	0.1753	1.31	3.42	0.4733	0.5785	0.8239	1.192	1.753
75	0.1481	1.44	3.33	0.3999	0.4887	0.6961	1.007	1.481
80	0.1256	1.57	3.25	0.3391	0.4145	0.5903	0.8541	1.256
85	0.1070	1.69	3.16	0.2889	0.3531	0.5029	0.7276	1.070
90	0.09155	1.81	3.09	0.2472	0.3021	0.4303	0.6225	0.9155
95	0.07861	1.93	3.01	0.2122	0.2594	0.3695	0.5345	0.7861
100	0.06775	2.04	2.94	0.1829	0.2236	0.3184	0.4607	0.6775
105	0.05860	2.15	2.87	0.1582	0.1934	0.2754	0.3985	0.5860
110	0.05086	2.26	2.80	0.1373	0.1678	0.2390	0.3458	0.5086
115	0.04429	2.37	2.73	0.1196	0.1462	0.2082	0.3012	0.4429
120	0.03870	2.47	2.67	0.1045	0.1277	0.1819	0.2632	0.3870
125	0.03392	2.57	2.61	0.0916	0.1119	0.1594	0.2307	0.3392
130	0.02982	2.67	2.55	0.0805	0.0984	0.1402	0.2028	0.2982
135	0.02629	2.77	2.49	0.0710	0.0868	0.1236	0.1788	0.2629
140	0.02324	2.86	2.43	0.0627	0.0767	0.1092	0.1580	0.2324
145	0.02061	2.95	3.38	0.0556	0.0680	0.0969	0.1402	0.2061
150	0.01832	3.05	2.33	0.0495	0.0605	0.0861	0.1246	0.1832

Temperature	Ratio R_T/R_{25}	Resistance Deviation due to β Tolerance	Temperature Coefficient	Resistance (kohm) for types 2322 640		
°C		%	%/°C	6.123	6.153	6.223
−40	25.80	10.24	6.09	309.5	386.9	567.5
−35	19.12	9.26	5.89	229.4	286.8	420.6
−30	14.31	8.31	5.70	171.7	214.6	314.8
−25	10.81	7.40	5.52	129.7	162.1	237.8
−20	8.235	6.53	5.35	98.82	123.5	181.2
−15	6.328	5.69	5.19	75.94	94.92	139.2
−10	4.902	4.88	5.03	58.82	73.52	107.8
−5	3.826	4.11	4.88	45.91	57.39	84.17
0	3.009	3.36	4.73	36.10	45.13	66.19
5	2.383	2.64	4.60	28.59	35.74	52.42
10	1.900	1.94	4.46	22.79	28.49	41.79
15	1.524	1.27	4.34	18.29	22.87	33.54
20	1.231	0.63	4.21	14.77	18.46	27.08
25	1.000	0.00	4.10	12.00	15.00	22.00
30	0.8171	0.61	3.98	9.805	12.26	17.98
35	0.6713	1.20	3.88	8.055	10.07	14.77
40	0.5545	1.79	3.77	6.653	8.317	12.20
45	0.4603	2.35	3.67	5.524	6.905	10.13
50	0.3840	2.91	3.57	4.609	5.761	8.449
55	0.3219	3.46	3.48	3.863	4.829	7.083
60	0.2711	3.99	3.39	3.253	4.067	5.964
65	0.2293	4.52	3.30	2.752	3.440	5.045
70	0.1948	5.03	3.22	2.337	2.922	4.285
75	0.1661	5.53	3.14	1.994	2.492	3.655
80	0.1423	6.02	3.06	1.707	2.134	3.130
85	0.1223	6.51	2.99	1.467	1.834	2.690
90	0.1055	6.98	2.92	1.266	1,582	2.321
95	0.09133	7.44	2.85	1.096	1,370	2.009
100	0.07935	7.90	2.78	0.9522	1,190	1.746
105	0.06917	8.34	2.71	0.8300	1,037	1.522
110	0.06048	8.78	2.65	0.7258	0.9072	1.331
115	0.05305	9.21	2.59	0.6366	0.7958	1.167
120	0.04668	9.63	2.53	0.5602	0.7002	1.027
125	0.04119	10.04	2.47	0.4943	0.6179	0.9061
130	0.03645	10.44	2.41	0.4374	0.5468	0.8019
135	0.03234	10.84	2.35	0.3881	0.4851	0.7115
140	0.02878	11.23	2.29	0.3453	0.4317	0.6332
145	0.02507	11.62	3.23	0.3080	0.3851	0.5647
150	0.02295	12.01	2.17	0.2754	0.3443	0.5049

SERIES 640-6

Temperature	Ratio R_T/R_{25}	Resistance Deviation due to β Tolerance	Temperature Coefficient	Resistance (kohm) for types 2322 640	
°C		%	%/°C	6.333	6.473
−40	34.15	7.32	6.57	1127	1605
−35	24.71	6.62	6.37	815.4	1161
−30	18.06	5.96	6.17	596.0	848.8
−25	13.33	5.32	5.98	439.9	626.5
−20	9.926	4.70	5.80	327.6	466.5
−15	7.458	4.10	5.63	246.1	350.5
−10	5.651	3.52	5.46	186.5	265.6
−5	4.317	2.97	5.31	142.5	202.9
0	3.324	2.43	5.15	109.7	156.2
5	2.578	1.91	5.01	85.07	121.2
10	2.014	1.41	4.87	66.46	94.66
15	1.585	0.92	4.73	52.30	74.49
20	1.255	0.45	4.60	41.42	58.99
25	1.000	0.00	4.48	33.00	47.00
30	0.8020	0.44	4.36	26.47	37.69
35	0.6469	0.88	4.24	21.35	30.40
40	0.5248	1.30	4.13	17.32	24.67
45	0.4280	1.71	4.02	14.12	20.12
50	0.3510	2.12	3.92	11.58	16.50
55	0.2892	2.51	3.82	9.544	13.59
60	0.2395	2.90	3.72	7.904	11.26
65	0.1993	3.28	3.63	6.577	9.367
70	0.1666	3.65	3.54	5.498	7.830
75	0.1399	4.01	3.45	4.617	6.574
80	0.1180	4.37	3.37	3.894	5.545
85	0.09988	4.72	3.29	3.296	4.694
90	0.08490	5.06	3.21	2.802	3.990
95	0.07244	5.39	3.13	2.390	3.404
100	0.06205	5.72	3.06	2.048	2.916
105	0.05333	6.04	2.99	1.760	2.507
110	0.04600	6.35	2.92	1.518	2.162
115	0.03981	6.66	2.86	1.314	1.871
120	0.03457	6.96	2.79	1.141	1.625
125	0.03011	7.26	2.73	0.9936	1.415
130	0.02633	7.55	2.67	0.8688	1.238
135	0.02307	7.84	2.61	0.7614	1.084
140	0.02028	8.12	2.55	0.6691	0.953
145	0.01787	8.40	2.49	0.5897	0.840
150	0.01579	8.68	2.44	0.5212	0.742

Temperature	Ratio R_T/R_{25}	Resistance Deviation due to β Tolerance	Temperature Coefficient	Resistance (kohm) for types 2322 640	
°C		%	%/°C	6.383	6.104
−40	36.65	7.47	6.70	2492	3665
−35	26.35	6.76	6.49	1792	2635
−30	19.14	6.08	6.29	1302	1914
−25	14.04	5.43	6.10	954.7	1404
−20	10.40	4.79	5.92	707.2	1040
−15	7.769	4.19	5.74	528.3	776.9
−10	5.855	3.60	5.57	398.1	585.5
−5	4.449	3.03	5.41	302.5	444.9
0	3.407	2.48	5.26	231.7	340.7
5	2.629	1.95	5.11	178.8	262.9
10	2.044	1.44	4.97	139.0	204.4
15	1.600	0.94	4.83	108.8	160.0
20	1.261	0.46	4.70	85.75	126.1
25	1.000	0.00	4.57	68.00	100.0
30	0.7982	0.45	4.45	54.28	79.82
35	0.6410	0.89	4.35	43.59	64.10
40	0.5176	1.33	4.22	35.20	51.76
45	0.4204	1.75	4.11	28.59	42.04
50	0.3432	2.16	4.00	23.34	34.32
55	0.2817	2.57	3.90	19.16	28.17
60	0.2323	2.96	3.80	15.80	23.23
65	0.1925	3.35	3.71	13.09	19.25
70	0.1603	3.73	3.62	10.90	16.03
75	0.1340	4.10	3.53	9.113	13.40
80	0.1126	4.46	3.45	7.654	11.26
85	0.09498	4.82	3.36	6.458	9.498
90	0.08043	5.17	3.28	5.469	8.043
95	0.06838	5.51	3.21	4.650	6.838
100	0.05836	5.85	3.13	3.969	5.836
105	0.04999	6.18	3.06	3.399	4.999
110	0.04297	6.50	2.99	2.922	4.297
115	0.03706	6.81	2.92	2.520	3.706
120	0.03207	7.12	2.86	2.181	3.207
125	0.02784	7.43	2.80	1.893	2.784
130	0.02425	7.73	2.74	1.649	2.425
135	0.02119	8.03	2.69	1.441	2.119
140	0.01856	8.33	2.64	1.262	1.856
145	0.01631	8.62	3.59	1.109	1.631
150	0.01437	8.91	2.54	0.977	1.437

SERIES 640-6

Temperature	Ratio R_T/R_{25}	Resistance Deviation due to β Tolerance	Temperature Coefficient	Resistance (kohm) for types 2322 640	
°C		%	%/°C	6.154	6.224
−40	41.38	11.82	6.89	6206	9103
−35	29.47	10.68	6.68	4420	6483
−30	21.20	9.60	6.48	3180	4664
−25	15.41	8.55	6.29	2311	3389
−20	11.30	7.55	6.11	1695	2486
−15	8.363	6.58	5.93	1254	1840
−10	6.243	5.65	5.76	936.5	1374
−5	4.700	4.75	5.60	704.9	1034
0	3.566	3.89	5.44	534.9	784.5
5	2.726	3.05	5.29	409.0	599.8
10	2.100	2.25	5.15	315.0	462.0
15	1.629	1.47	5.01	244.3	358.4
20	1.272	0.72	4.88	190.8	279.9
25	1.000	0.00	4.75	150.0	220.0
30	0.7911	0.71	4.62	118.7	174.0
35	0.6296	1.40	4.51	94.44	138.5
40	0.5040	2.08	4.39	75.60	110.9
45	0.4058	2.74	4.28	60.87	89.27
50	0.3285	3.40	4.17	49.27	72.26
55	0.2673	4.04	4.07	40.09	58.80
60	0.2186	4.67	3.97	32.79	48.09
65	0.1797	5.28	3.87	26.95	39.53
70	0.1484	5.89	3.78	22.25	32.64
75	0.1231	6.49	3.69	18.46	27.08
80	0.1026	7.07	3.60	15.38	22.56
85	0.08582	7.64	3.52	12.87	18.88
90	0.07211	8.21	3.44	10.82	15.86
95	0.06083	8.76	3.36	9.125	13.38
100	0.05152	9.31	3.28	7.728	11.33
105	0.04380	9.84	3.21	6.570	9.635
110	0.03737	10.36	3.14	5.605	8.221
115	0.03199	10.88	3.07	4.799	7.038
120	0.02749	11.39	3.00	4.124	6.048
125	0.02369	11.88	2.94	3.554	5.212
130	0.02049	12.36	2.88	3.073	4.508
135	0.01778	12.83	2.82	2.666	3.912
140	0.01547	13.29	2.76	2.320	3.403
145	0.01349	13.74	2.71	2.024	2.968
150	0.01181	14.18	2.66	1.771	2.598

Temperature	Ratio R_T/R_{25}	Resistance Deviation due to β Tolerance	Temperature Coefficient	Resistance (kohm) for types 2322 640	
°C		%	%/°C	6.334	6.474
−40	47.68	12.29	7.13	15730	22410
−35	33.56	11.12	6.91	11080	15770
−30	23.87	9.99	6.71	7878	11220
−25	17.15	8.90	6.52	5659	8060
−20	12.44	7.86	6.33	4104	5846
−15	9.103	6.85	6.15	3004	4279
−10	6.721	5.88	5.98	2218	3159
−5	5.005	4.95	5.82	1651	2352
0	3.756	4.05	5.66	1240	1766
5	2.842	3.18	5.50	937.8	1336
10	2.166	2.35	5.36	714.7	1018
15	1.663	1.54	5.22	548.6	781.4
20	1.285	0.76	5.08	424.1	604.0
25	1.000	0.00	4.95	330.0	470.0
30	0.7832	0.74	4.82	258.4	368.1
35	0.6172	1.46	4.70	203.7	290.1
40	0.4893	2.17	4.59	161.5	229.9
45	0.3901	2.86	4.47	128.7	183.3
50	0.3128	3.55	4.36	103.2	147.0
55	0.2521	4.22	4.26	83.21	118.5
60	0.2043	4.88	4.15	67.42	96.03
65	0.1664	5.53	4.06	54.91	78.20
70	0.1362	6.16	3.96	44.93	64.00
75	0.1120	6.79	3.87	36.94	52.62
80	0.09247	7.40	3.78	30.51	43.46
85	0.07671	8.01	3.69	25.31	36.05
90	0.06391	8.60	3.61	21.09	30.04
95	0.05346	9.18	3.53	17.64	25.13
100	0.04490	9.76	3.45	14.82	21.10
105	0.03786	10.32	3.37	12.49	17.79
110	0.03204	10.87	3.30	10.57	15.06
115	0.02722	11.42	3.23	8.983	12.79
120	0.02320	11.95	3.16	7.656	10.90
125	0.01984	12.48	3.09	6.547	9.325
130	0.01704	13.00	3.03	5.623	8.009
135	0.01467	13.52	2.97	4.841	6.895
140	0.01267	14.03	2.91	4.181	5.955
145	0.01098	14.54	2.85	3.623	5.161
150	0.00954	15.04	2.80	3.148	4.484

SERIES 640-9

NTC Thermistors in Stainless Steel Housings

DESCRIPTION

The Series 640-9 NTC Thermistors are stainless steel housings designed for fluid temperature measurement.

ELECTRICAL SPECIFICATIONS

Dissipation . . . . 250 mW maximum

Dissipation Factor . . . . In still air approx. 7.5 mW/°C

. . . . In still water approx. 18 mW/°C

Operating Temperature Range:

−25°C to +110°C continuous
+113°C peak for 24 hours
0 to +55°C Maximum Power

Thermal Time Constant: . . . . approx. 285 seconds in still air

. . . . approx. 11 seconds in liquid

Dielectric Withstanding Voltage between terminals and capsule

. . . . 1500 VRMS for 60 seconds

. . . . 1650 VRMS for 10 seconds

MECHANICAL DATA

Marking
Color Dot between terminals

Weight
Approx. 8 grams

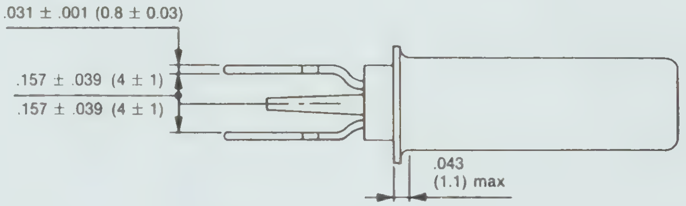
Mounting
AMP terminals in any position

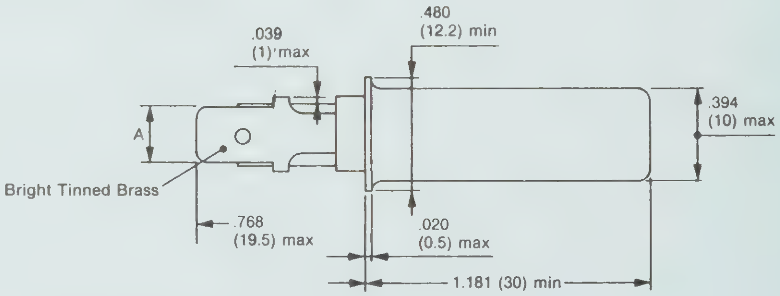
Robustness of Terminations:
Tensile Strength: 11 lbs (50 N)

Vibration
10 to 45 HZ .098" (2.5mm) amplitude
45 to 2000 HZ 20g peak
1H in each of 3 axes
2 octaves per minute

Impact
39.4" (1000mm)

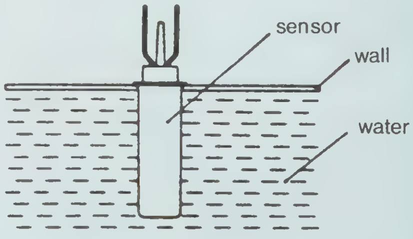
Non-flammable





All dimensions in inches (mm)

Resistance @ 25°C (ohms)	Resistance @ 90°C (ohms)	Dimension "A" inches (mm)	Part Number	Color Dot Marking	β 25/85 (±5%)
2,700	245	.110 (2.8)	2322-640-90022	Green	3997
2,700	245	.248 (6.3)	2322-640-90023	Grey	3997
12,000	1,300	.110 (2.8)	2322-640-90011	Brown	3700
12,000	1,300	.248 (6.3)	2322-640-90007	Brown	3700



SERIES 642-6
NTC Thermistors for Temperature Measurement and Compensation

DESCRIPTION

The Series 642-6 NTC Thermistors are radial leaded, color coded devices intended for general use. Available in 10% and 5%.

ELECTRICAL SPECIFICATIONS

Dissipation . . . . .500 mW maximum
Dissipation Factor . . . .8.5 mW/°C
Operating Temperature Range . . . .−40°C to +150°C
Thermal Time Constant. . . . .approx. 17 seconds in still air

MECHANICAL DATA

Marking
4 color bands

Weight
Approx. 0.25 grams

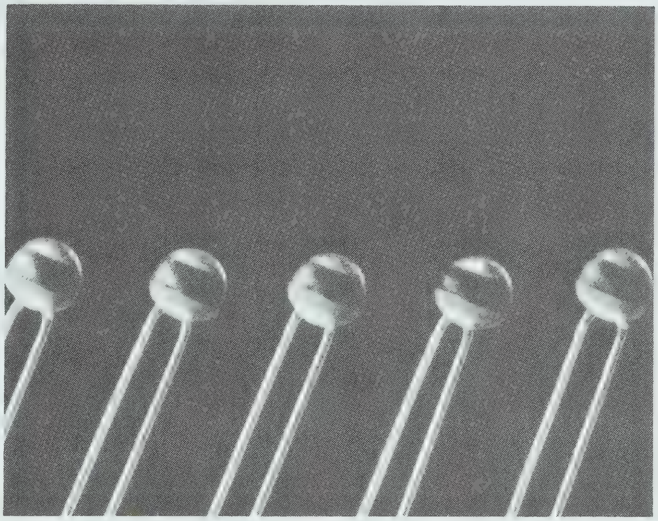
Mounting
In any position by soldering

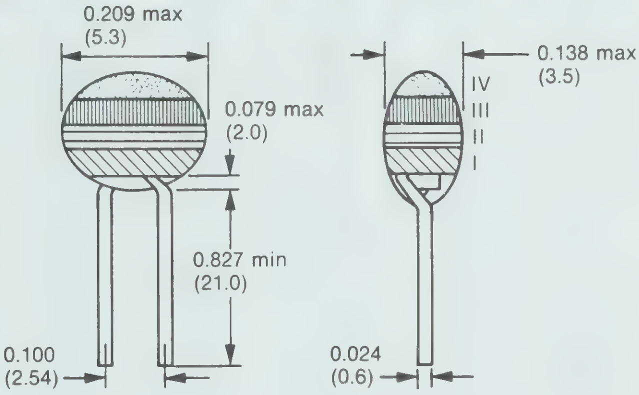
Robustness of Terminations:
Tensile Strength: 2.25 lbs (10 N)
Bending: 1.12 lbs (5 N)

Soldering
Solderability: Max. 240°C-Max. 4 seconds
Resistance to Heat: 260 ±5°C 10 ±1 seconds

Impact
Free Fall 39.4″ (1000mm)

Self-Extinguishing





All dimensions in inches (mm)

Resistance @ 25°C	Part Number (By Tolerance) ±10%	±5%	β25/85 ±5%	T_C (%/°C) (25°C)
3.3	2322-642-62338	2322-642-63338	2675	−3.0
4.7	2322-642-62478	2322-642-64782	2750	−3.1
6.8	2322-642-62688	2322-642-63688	2800	−3.2
10.0	2322-642-62109	2322-642-63109	2875	−3.2
15.0	2322-642-62159	2322-642-63159	2950	−3.3
22.0	2322-642-62229	2322-642-63229	3025	−3.4
33.0	2322-642-62339	2322-642-63339	3100	−3.5
47.0	2322-642-62479	2322-642-63479	3150	−3.5
68.0	2322-642-62689	2322-642-63689	3225	−3.6
100.0	2322-642-62101	2322-642-63101	3300	−3.7
150.0	2322-642-62151	2322-642-63151	3375	−3.8
220.0	2322-642-62221	2322-642-63221	3475	−3.9
330.0	2322-642-62331	2322-642-63331	3575	−4.0
470.0	2322-642-62471	2322-642-63471	3650	−4.1
680.0	2322-642-62681	2322-642-63681	3725	−4.2
1,000.0	2322-642-62102	2322-642-63102	3825	−4.3
1,500.0	2322-642-62152	2322-642-63152	3975	−4.5
2,200.0	2322-642-62222	2322-642-63222	4125	−4.6

Color Coding: Band I & II Resistance at 25°C		Band III Multiplier	Band IV Tolerance
0 = Black	5 = Green	10^0 = Black	
1 = Brown	6 = Blue	10^1 = Brown	
2 = Red	7 = Violet	10^2 = Red	
3 = Orange	8 = Grey	10^3 = Orange	10% = Silver
4 = Yellow	9 = White	10^4 = Yellow	5% = Gold

SERIES 642-6

Temp °C	2322-642 -63338 R Ohms	2322-642 -63478 R Ohms	2322-642 -63688 R Ohms	2322-642 -63109 R Ohms	2322-642 -63159 R Ohms	2322-642 -63229 R Ohms	2322-642 -63339 R Ohms
−40	24.61	37.62	56.98	90.67	146.08	229.79	370.20
−35	20.75	31.50	47.50	75.00	120.00	187.50	300.00
−30	17.55	26.46	39.73	62.27	98.97	153.65	244.22
−25	14.88	22.30	33.35	51.89	81.95	126.43	199.69
−20	12.66	18.85	28.08	43.39	68.11	104.45	163.97
−15	10.79	15.98	23.71	36.40	56.81	86.63	135.20
−10	9.23	13.59	20.09	30.65	47.55	72.12	111.91
−5	7.91	11.58	17.07	25.88	39.94	60.25	93.00
0	6.80	9.90	14.54	21.92	33.66	50.52	77.57
5	5.85	8.49	12.42	18.63	28.46	42.50	64.93
10	5.05	7.29	10.64	15.88	24.14	35.88	54.55
15	4.37	6.28	9.14	13.57	20.54	30.39	45.98
20	3.80	5.43	7.88	11.63	17.53	25.82	38.89
25	3.30	4.70	6.80	10.00	15.00	22.00	33.00
30	2.88	4.08	5.89	8.62	12.88	18.81	28.09
35	2.51	3.55	5.11	7.45	11.08	16.12	23.99
40	2.20	3.10	4.45	6.46	9.57	13.86	20.55
45	1.93	2.71	3.88	5.61	8.28	11.95	17.65
50	1.70	2.37	3.39	4.88	7.19	10.34	15.21
55	1.50	2.08	2.97	4.27	6.25	8.96	13.14
60	1.32	1.83	2.61	3.73	5.45	7.79	11.38
65	1.17	1.62	2.30	3.28	4.77	6.79	9.89
70	1.04	1.43	2.03	2.88	4.18	5.94	8.61
75	0.923	1.27	1.79	2.54	3.68	5.20	7.52
80	0.822	1.13	1.59	2.25	3.24	4.57	6.59
85	0.734	1.00	1.41	1.99	2.86	4.02	5.78
90	0.657	0.894	1.26	1.77	2.53	3.55	5.09
95	0.589	0.799	1.12	1.57	2.25	3.14	4.49
100	0.529	0.716	1.00	1.40	2.00	2.78	3.97
105	0.476	0.643	0.897	1.25	1.78	2.47	3.52
110	0.430	0.578	0.805	1.12	1.59	2.20	3.12
115	0.388	0.521	0.724	1.01	1.42	1.97	2.78
120	0.352	0.471	0.652	0.903	1.27	1.76	2.48
125	0.319	0.426	0.589	0.814	1.15	1.58	2.22
130	0.290	0.386	0.533	0.735	1.03	1.42	1.99
135	0.265	0.351	0.483	0.665	0.930	1.27	1.78
140	0.242	0.319	0.439	0.602	0.841	1.15	1.60
145	0.221	0.291	0.399	0.547	0.761	1.04	1.45
150	0.202	0.266	0.364	0.497	0.691	0.939	1.31

Temp °C	2322-642 -63479 R Ohms	2322-642 -63689 R Ohms	2322-642 -63101 R Ohms	2322-642 -63151 R Ohms	2322-642 -63221 R Ohms	2322-642 -63331 R Ohms	2322-642 -63471 R Ohms
−40	552.90	854.42	1355.21	2023.93	3256.86	5354.54	8852.42
−35	446.00	685.00	1078.50	1617.50	2580.00	4205.00	6835.50
−30	361.48	551.90	862.81	1298.42	2053.54	3319.03	5310.41
−25	294.31	446.79	693.76	1046.76	1642.03	2632.60	4149.99
−20	240.69	363.36	560.56	847.38	1318.85	2098.07	3261.71
−15	197.67	296.83	455.07	688.76	1063.86	1679.78	2577.77
−10	163.02	243.53	371.12	562.03	861.79	1350.91	2048.20
−5	134.98	200.63	304.00	460.38	700.96	1091.16	1635.91
0	112.19	165.95	250.08	378.53	572.42	885.10	1313.23
5	93.61	137.81	206.57	312.36	469.28	720.91	1059.38
10	78.38	114.88	171.32	258.68	386.18	589.55	858.70
15	65.87	96.11	142.64	212.98	318.98	484.02	699.27
20	55.55	80.70	119.21	179.27	264.44	398.91	572.02
25	47.00	68.00	100.00	150.00	220.00	330.00	470.00
30	39.90	57.49	84.18	125.92	183.67	274.00	387.83
35	33.98	48.77	71.12	106.05	153.87	228.32	321.38
40	29.03	41.51	60.28	89.60	129.33	190.93	267.39
45	24.87	35.43	51.27	75.94	109.07	160.22	223.37
50	21.38	30.34	43.74	64.57	92.28	134.90	187.32
55	18.43	26.06	37.44	55.06	78.33	113.96	157.68
60	15.93	22.45	32.14	47.10	66.69	96.59	133.22
65	13.81	19.40	27.68	40.40	56.96	82.13	112.97
70	12.00	16.80	23.90	34.76	48.79	70.05	96.13
75	10.46	14.60	20.70	29.99	41.92	59.93	82.08
80	9.14	12.72	17.98	25.95	36.13	51.43	70.33
85	8.01	11.11	15.66	22.52	31.22	44.27	60.45
90	7.03	9.72	13.67	19.59	27.06	38.22	52.13
95	6.19	8.54	11.97	17.09	23.51	33.09	45.09
100	5.46	7.51	10.51	14.95	20.49	28.72	39.13
105	4.83	6.63	9.24	13.11	17.91	25.01	34.05
110	4.28	5.86	8.15	11.53	15.69	21.83	29.72
115	3.81	5.19	7.21	10.16	13.78	19.11	26.01
120	3.39	4.61	6.39	8.98	12.14	16.77	22.83
125	3.03	4.10	5.67	7.96	10.71	14.75	20.09
130	2.71	3.66	5.05	7.06	9.48	13.01	17.73
135	2.43	3.27	4.51	6.29	8.41	11.51	15.69
140	2.18	2.93	4.03	5.61	7.48	10.20	13.91
145	1.96	2.63	3.61	5.02	6.67	9.06	12.37
150	1.77	2.37	3.24	4.50	5.96	8.07	11.02

SERIES 642-6

Temp °C	2322-642 -63681 R Ohms	2322-642 -63102 R Ohms	2322-642 -63152 R Ohms	2322-642 -63222 R Ohms
−40	11252.69	20487.67	35038.17	58579.87
−35	8850.00	15735.00	26587.50	43920.00
−30	6992.17	12156.49	20302.26	33148.86
−25	5548.69	9445.59	15597.23	25180.61
−20	4421.91	7379.82	12053.09	19246.91
−15	3538.43	5796.72	9367.30	14800.11
−10	2842.72	4576.85	7320.12	11447.08
−5	2292.60	3631.88	5750.91	8903.75
0	1855.86	2896.10	4541.53	6963.48
5	1507.78	2320.34	3604.54	5475.02
10	1229.33	1867.64	2874.88	4326.99
15	1005.76	1510.01	2303.84	3436.88
20	825.63	1226.21	1854.78	2743.23
25	680.00	1000.00	1500.00	2200.00
30	561.86	818.91	1218.42	1772.53
35	465.72	673.34	993.94	1434.57
40	387.22	555.85	814.22	1166.17
45	322.94	460.63	669.71	952.06
50	270.14	383.17	553.05	780.51
55	226.63	319.91	458.49	642.50
60	190.68	268.06	381.55	531.00
65	160.90	225.41	318.70	440.56
70	136.14	190.20	267.16	366.92
75	115.52	161.03	224.76	306.72
80	98.29	136.79	189.74	257.34
85	83.85	116.57	160.73	216.67
90	71.73	99.66	136.60	183.06
95	61.52	85.46	116.47	155.19
100	52.90	73.51	99.62	132.00
105	45.60	63.42	85.48	112.64
110	39.41	54.88	73.56	96.42
115	34.15	47.62	63.50	82.79
120	29.66	41.43	54.97	71.31
125	25.83	36.15	47.72	61.60
130	22.54	31.62	41.54	53.36
135	19.72	27.74	36.26	46.36
140	17.29	24.39	31.74	40.39
145	15.20	21.50	27.85	35.28
150	13.39	19.00	24.50	30.90

SERIES 642-7

NTC Thermistors for Temperature Measurement and Compensation

DESCRIPTION

The Series 642-7 NTC Thermistors are mounted in a metric threaded aluminum bolt and are intended for general use. Available in 10% and 5%.

ELECTRICAL SPECIFICATIONS

Dissipation .... 500 mW Maximum
Dissipation Factor . . . 23 mW/°C
Operating Temperature Range .... −40°C to +150°C
Thermal Time Constant ..... approx. 7.5 seconds in still air
Dielectric between Terminals and Screw .... 100 VRMS minimum

MECHANICAL DATA

Marking
Last four digits of part number

Weight
Approx. 1.38 grams

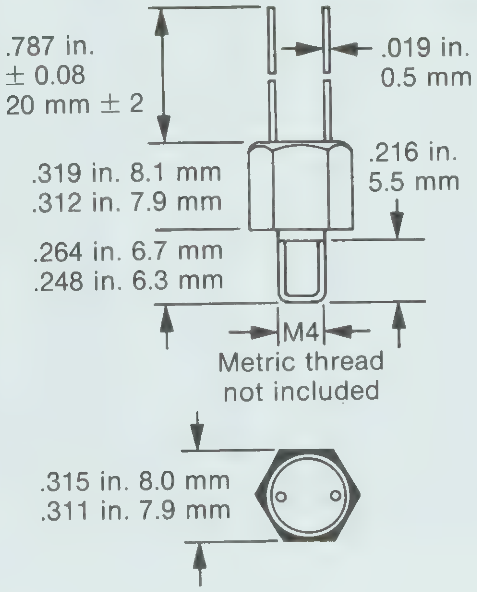
Mounting
In any position by means of a washer and nut (provided). Leads to be soldered.

Robustness of Terminations
Tensile Strength: 2.25 lbs (10 N)
Bending: 1.12 lbs (5 N)
Torque: .885 ft-lb (1.2 Nm)

Soldering
Solderability: Max. 24°C-Max. 4 seconds
Resistance to Heat: 260 ±5°C 10 ±1 seconds

Impact
Free Fall 3.94″ (100mm)

Self-Extinguishing



All dimensions in inches (mm)

Resistance @ 25°C	Part Number (By Tolerance)		β25/85 ±5%	T_C (%/°C) (25°C)
	±10%	±5%		
3.3	2322-642-72338	2322-642-73338	2675	−3.0
4.7	2322-642-72478	2322-642-74782	2750	−3.1
6.8	2322-642-72688	2322-642-73688	2800	−3.2
10.0	2322-642-72109	2322-642-73109	2875	−3.2
15.0	2322-642-72159	2322-642-73159	2950	−3.3
22.0	2322-642-72229	2322-642-73229	3025	−3.4
33.0	2322-642-72339	2322-642-73339	3100	−3.5
47.0	2322-642-72479	2322-642-73479	3150	−3.5
68.0	2322-642-72689	2322-642-73689	3225	−3.6
100.0	2322-642-72101	2322-642-73101	3300	−3.7
150.0	2322-642-72151	2322-642-73151	3375	−3.8
220.0	2322-642-72221	2322-642-73221	3475	−3.9
330.0	2322-642-72331	2322-642-73331	3575	−4.0
470.0	2322-642-72471	2322-642-73471	3650	−4.1
680.0	2322-642-72681	2322-642-73681	3725	−4.2
1,000.0	2322-642-72102	2322-642-73102	3825	−4.3
1,500.0	2322-642-72152	2322-642-73152	3975	−4.5
2,200.0	2322-642-72222	2322-642-73222	4125	−4.6

Series 642-7

Temp °C	2322-642 7.338 R Ohms	2322-642 7.478 R Ohms	2322-642 7.688 R Ohms	2322-642 7.109 R Ohms	2322-642 7.159 R Ohms	2322-642 7.229 R Ohms	2322-642 7.339 R Ohms
−40	24.61	37.62	56.98	90.67	146.08	229.79	370.20
−35	20.75	31.50	47.50	75.00	120.00	187.50	300.00
−30	17.55	26.46	39.73	62.27	98.97	153.65	244.22
−25	14.88	22.30	33.35	51.89	81.95	126.43	199.69
−20	12.66	18.85	28.08	43.39	68.11	104.45	163.97
−15	10.79	15.98	23.71	36.40	56.81	86.63	135.20
−10	9.23	13.59	20.09	30.65	47.55	72.12	111.91
−5	7.91	11.58	17.07	25.88	39.94	60.25	93.00
0	6.80	9.90	14.54	21.92	33.66	50.52	77.57
5	5.85	8.49	12.42	18.63	28.46	42.50	64.93
10	5.05	7.29	10.64	15.88	24.14	35.88	54.55
15	4.37	6.28	9.14	13.57	20.54	30.39	45.98
20	3.80	5.43	7.88	11.63	17.53	25.82	38.89
25	**3.30**	**4.70**	**6.80**	**10.00**	**15.00**	**22.00**	**33.00**
30	2.88	4.08	5.89	8.62	12.88	18.81	28.09
35	2.51	3.55	5.11	7.45	11.08	16.12	23.99
40	2.20	3.10	4.45	6.46	9.57	13.86	20.55
45	1.93	2.71	3.88	5.61	8.28	11.95	17.65
50	1.70	2.37	3.39	4.88	7.19	10.34	15.21
55	1.50	2.08	2.97	4.27	6.25	8.96	13.14
60	1.32	1.83	2.61	3.73	5.45	7.79	11.38
65	1.17	1.62	2.30	3.28	4.77	6.79	9.89
70	1.04	1.43	2.03	2.88	4.18	5.94	8.61
75	0.923	1.27	1.79	2.54	3.68	5.20	7.52
80	0.822	1.13	1.59	2.25	3.24	4.57	6.59
85	0.734	1.00	1.41	1.99	2.86	4.02	5.78
90	0.657	0.894	1.26	1.77	2.53	3.55	5.09
95	0.589	0.799	1.12	1.57	2.25	3.14	4.49
100	0.529	0.716	1.00	1.40	2.00	2.78	3.97
105	0.476	0.643	0.897	1.25	1.78	2.47	3.52
110	0.430	0.578	0.805	1.12	1.59	2.20	3.12
115	0.388	0.521	0.724	1.01	1.42	1.97	2.78
120	0.352	0.471	0.652	0.903	1.27	1.76	2.48
125	0.319	0.426	0.589	0.814	1.15	1.58	2.22
130	0.290	0.386	0.533	0.735	1.03	1.42	1.99
135	0.265	0.351	0.483	0.665	0.930	1.27	1.78
140	0.242	0.319	0.439	0.602	0.841	1.15	1.60
145	0.221	0.291	0.399	0.547	0.761	1.04	1.45
150	0.202	0.266	0.364	0.497	0.691	0.939	1.31

NOTE: Replace "." with "2" for 10% tolerance
Replace "." with "3" for 5% tolerance

Temp °C	2322-642 7.479 R Ohms	2322-642 7.689 R Ohms	2322-642 7.101 R Ohms	2322-642 7.151 R Ohms	2322-642 7.221 R Ohms	2322-642 7.331 R Ohms	2322-642 7.471 R Ohms
−40	552.90	854.42	1355.21	2023.93	3256.86	5354.54	8852.42
−35	446.00	685.00	1078.50	1617.50	2580.00	4205.00	6835.50
−30	361.48	551.90	862.81	1298.42	2053.54	3319.03	5310.41
−25	294.31	446.79	693.76	1046.76	1642.03	2632.60	4149.99
−20	240.69	363.36	560.56	847.38	1318.85	2098.07	3261.71
−15	197.67	296.83	455.07	688.76	1063.86	1679.78	2577.77
−10	163.02	243.53	371.12	562.03	861.79	1350.91	2048.20
−5	134.98	200.63	304.00	460.38	700.96	1091.16	1635.91
0	112.19	165.95	250.08	378.53	572.42	885.10	1313.23
5	93.61	137.81	206.57	312.36	469.28	720.91	1059.38
10	78.38	114.88	171.32	258.68	386.18	589.55	858.70
15	65.87	96.11	142.64	212.98	318.98	484.02	699.27
20	55.55	80.70	119.21	179.27	264.44	398.91	572.02
25	**47.00**	**68.00**	**100.00**	**150.00**	**220.00**	**330.00**	**470.00**
30	39.90	57.49	84.18	125.92	183.67	274.00	387.83
35	33.98	48.77	71.12	106.05	153.87	228.32	321.38
40	29.03	41.51	60.28	89.60	129.33	190.93	267.39
45	24.87	35.43	51.27	75.94	109.07	160.22	223.37
50	21.38	30.34	43.74	64.57	92.28	134.90	187.32
55	18.43	26.06	37.44	55.06	78.33	113.96	157.68
60	15.93	22.45	32.14	47.10	66.69	96.59	133.22
65	13.81	19.40	27.68	40.40	56.96	82.13	112.97
70	12.00	16.80	23.90	34.76	48.79	70.05	96.13
75	10.46	14.60	20.70	29.99	41.92	59.93	82.08
80	9.14	12.72	17.98	25.95	36.13	51.43	70.33
85	8.01	11.11	15.66	22.52	31.22	44.27	60.45
90	7.03	9.72	13.67	19.59	27.06	38.22	52.13
95	6.19	8.54	11.97	17.09	23.51	33.09	45.09
100	5.46	7.51	10.51	14.95	20.49	28.72	39.13
105	4.83	6.63	9.24	13.11	17.91	25.01	34.05
110	4.28	5.86	8.15	11.53	15.69	21.83	29.72
115	3.81	5.19	7.21	10.16	13.78	19.11	26.01
120	3.39	4.61	6.39	8.98	12.14	16.77	22.83
125	3.03	4.10	5.67	7.96	10.71	14.75	20.09
130	2.71	3.66	5.05	7.06	9.48	13.01	17.73
135	2.43	3.27	4.51	6.29	8.41	11.51	15.69
140	2.18	2.93	4.03	5.61	7.48	10.20	13.91
145	1.96	2.63	3.61	5.02	6.67	9.06	12.37
150	1.77	2.37	3.24	4.50	5.96	8.07	11.02

NOTE: Replace "." with "2" for 10% tolerance
Replace "." with "3" for 5% tolerance

Series 642-7

Temp °C	2322-642 7.681 R Ohms	2322-642 7.102 R Ohms	2322-642 7.152 R Ohms	2322-642 7.222 R Ohms
−40	11252.69	20487.67	35038.17	58579.87
−35	8850.00	15735.00	26587.50	43920.00
−30	6992.17	12156.49	20302.26	33148.86
−25	5548.69	9445.59	15597.23	25180.61
−20	4421.91	7379.82	12053.09	19246.91
−15	3538.43	5796.72	9367.30	14800.11
−10	2842.72	4576.85	7320.12	11447.08
−5	2292.60	3631.88	5750.91	8903.75
0	1855.86	2896.10	4541.53	6963.48
5	1507.78	2320.34	3604.54	5475.02
10	1229.33	1867.64	2874.88	4326.99
15	1005.76	1510.01	2303.84	3436.88
20	825.63	1226.21	1854.78	2743.23
25	**680.00**	**1000.00**	**1500.00**	**2200.00**
30	561.86	818.91	1218.42	1772.53
35	465.72	673.34	993.94	1434.57
40	387.22	555.85	814.22	1166.17
45	322.94	460.63	669.71	952.06
50	270.14	383.17	553.05	780.51
55	226.63	319.91	458.49	642.50
60	190.68	268.06	381.55	531.00
65	160.90	225.41	318.70	440.56
70	136.14	190.20	267.16	366.92
75	115.52	161.03	224.76	306.72
80	98.29	136.79	189.74	257.34
85	83.85	116.57	160.73	216.67
90	71.73	99.66	136.60	183.06
95	61.52	85.46	116.47	155.19
100	52.90	73.51	99.62	132.00
105	45.60	63.42	85.48	112.64
110	39.41	54.88	73.56	96.42
115	34.15	47.62	63.50	82.79
120	29.66	41.43	54.97	71.31
125	25.83	36.15	47.72	61.60
130	22.54	31.62	41.54	53.36
135	19.72	27.74	36.26	46.36
140	17.29	24.39	31.74	40.39
145	15.20	21.50	27.85	35.28
150	13.39	19.00	24.50	30.90

NOTE: Replace "." with "2" for 10% tolerance
Replace "." with "3" for 5% tolerance

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SERIES 644-9
NTC Thermistors for Surge Current Limiting

DESCRIPTION

The Series 644-9 NTC Thermistors are designed for surge current limiting applications.

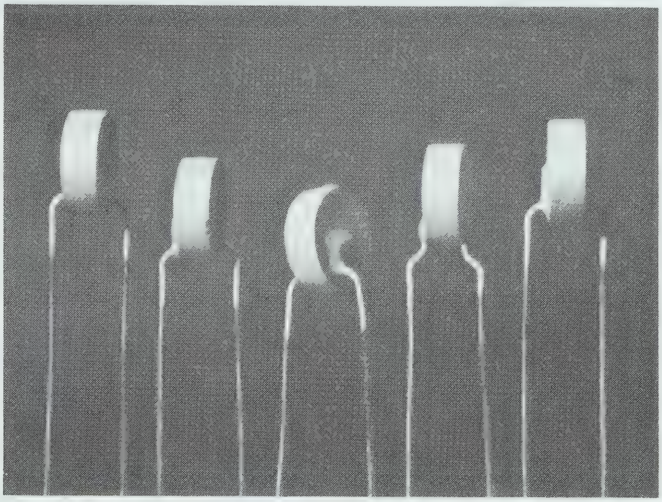
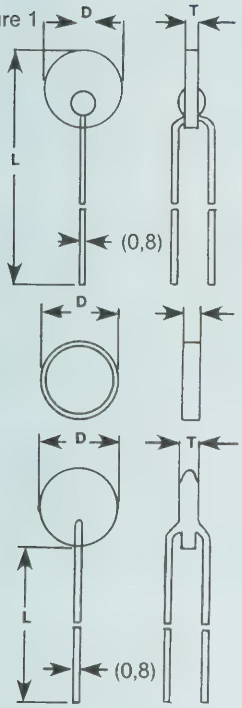


Figure 1



Size	D (max.)	F (max.)	L (min.)
3B	.630 (16)	.197 (5)	2.2 (56)
3C	.995 (24)	.197 (5)	2.3 (59)
4B	.669 (17)	.161 (4.1)	–
5A	.531 (13.5)	.157 (4)	1.4 (38)
5B	.531 (13.5)	.177 (4.5)	1.4 (38)
5C	.531 (13.5)	.192 (5)	1.4 (38)
5D	.531 (13.5)	.236 (6)	1.4 (38)
5E	.374 (10)	.177 (4.5)	1.4 (38)
5F	.945 (24)	.256 (6.5)	1.4 (38)
5G	.945 (24)	.276 (7)	1.4 (38)

Dimensions in inches (mm)

Part Number	Resistance at 25°C ±25% (ohms)	Resistance at I max (ohms)	Maximum continuous current, 0 to 55°C (A)	Approximate dissipation factor (mW/K)	Size (see Fig. 1)
644 90005	15	<1	2.2	17	3B
644 90008	20	0.20	5	21	3C
644 90013	20	0.15	6	21	3C
644 90012	5	<0.50	8	depends on mounting method	4B
644 90016	2.5	0.056	8	14	5A
644 90017	4	0.063	8	15	5B
644 90018	5	0.04	7	15.5	5C
644 90019	7	0.120	6	16	5D
644 90021	10	0.300	3	12	5E
644 90022	2	0.033	15	27	5F
644 90023	2.5	0.048	12	28	5G
644 90025	20	–	5	–	3C
644 90026	20	1.0	2.2	13	5E

SURGE CURRENT LIMITING

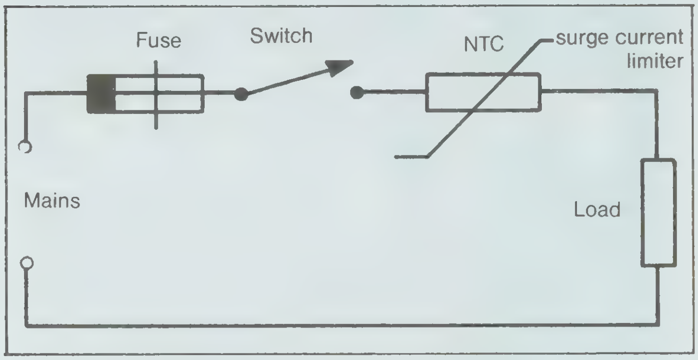
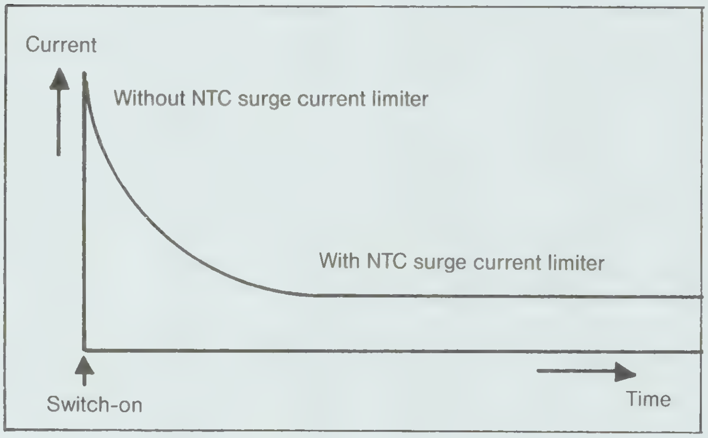


Fig. 2 Typical mains input circuit with an NTC surge current limiter in the input line. The current/time characteristics shows the suppression effect of the NTC surge current limiter.



SURGE CURRENT LIMITING

Surge currents occurring when electrical appliances are switched on can cause serious problems. Circuit components can easily be damaged and high starting torques can quickly wear out belts and moving parts. However, surges can be prevented using just one small component–the negative temperature coefficient (NTC) surge current limiter.

Fig. 2 shows a typical mains input circuit with an NTC surge current limiter in the input line. At switch-on, the 'cold' resistance of the surge current limiter is high enough to limit the surge current to a safe level but after a few milliseconds, during which time the surge has been suppressed, the surge current limiter has heated up and its resistance has fallen to a value that allows normal operation of the equipment. A period of 30 to 60 seconds must be allowed between switching-off and switching-on again for it to cool down, otherwise, only partial transient protection may be provided.

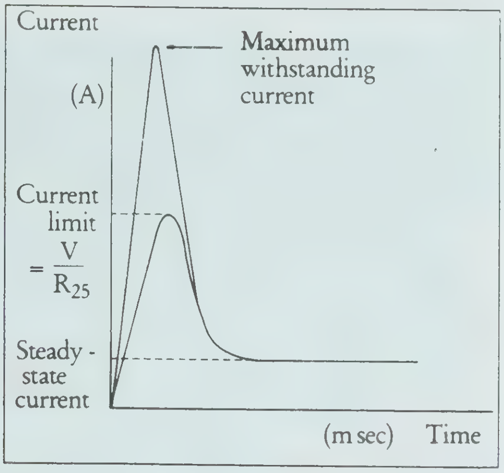


Fig. 3 Typical current/time characteristics of our surge current limiters. Maximum withstanding current of more than 8 times the specified maximum continous current proves that our surge current limiters will repeatedly withstand severe transients.

MAXIMUM WITHSTANDING CURRENT

It is very difficult to define the maximum withstanding current (Fig. 3) that our surge current limiters can handle before breaking down. During normal operation the current limit of our surge current limiters is defined by V/R_{25}, where V is the applied voltage. However, we've tested our 644 90018 surge current limiters under overload conditions and we've established that they can withstand at least 60 A surge current without any apparent degradation, and since this figure is more than eight times the specified maximum continuous current, there's no doubt that our surge current limiters will repeatedly withstand severe transients.

SERIES 644-9

MOUNTING

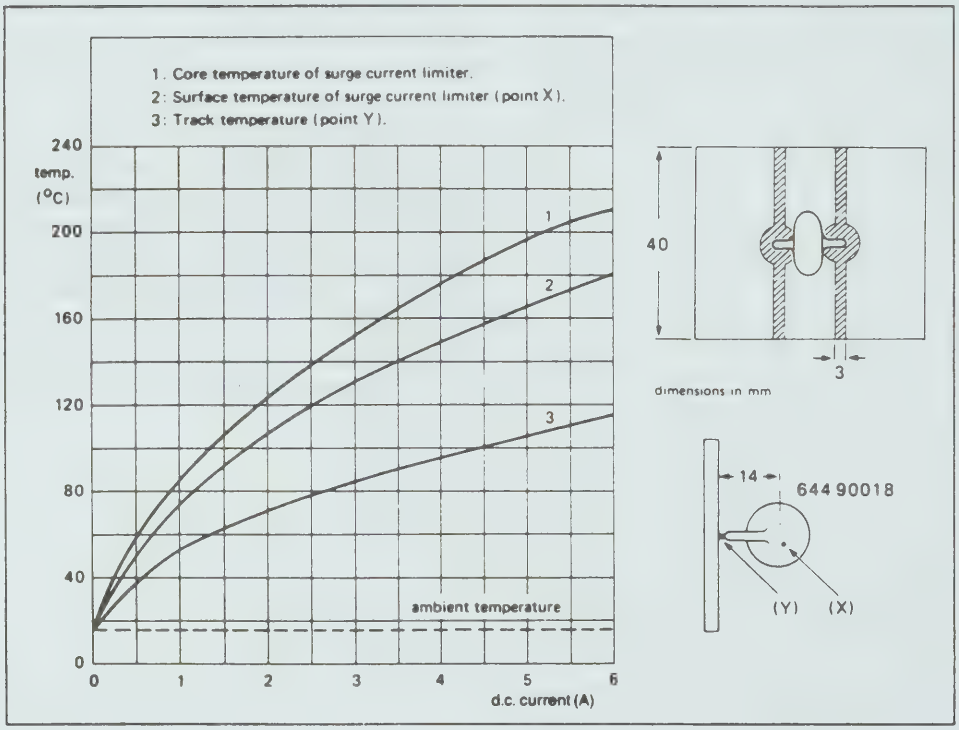
Under steady-state conditions our surge current limiters can become quite hot. However, their long leads prevent overheating of pcb tracks and melting of soldered joints. Therefore, the leads should not be shortened excessively if mounted in free air.

Figure 4 shows typical measured temperatures under various surge currents for a 644 90018 surge current limiter. Of course the surge current limiter could also be cooled by a fan or mounted on a heatsink. Our Applications Department will be pleased to advise on mounting methods for your particular application.

APPLICATIONS

Our surge current limiters are ideal for:

- Limiting surge currents to national standard levels of mains pollution.
- Protecting semiconductor devices from surges.
- Preventing fuse-blowing at switch-on.
- Preventing excessive wearout of belts and moving parts by reducing starting torque.
- Increasing lifetime of projector and other lamps, particularly where long life is important and access is difficult (e.g. swimming pools, street lamps).
- Protecting switch contacts. They are used with: power supplies, a.c. and d.c. motors, transformers, power-factor capacitors, relays, filament lamps, projector lamps, street lighting, personal computers, video monitors, chainsaws, power drills, vacuum cleaners, solariums, microwave cookers...and numerous other applications.



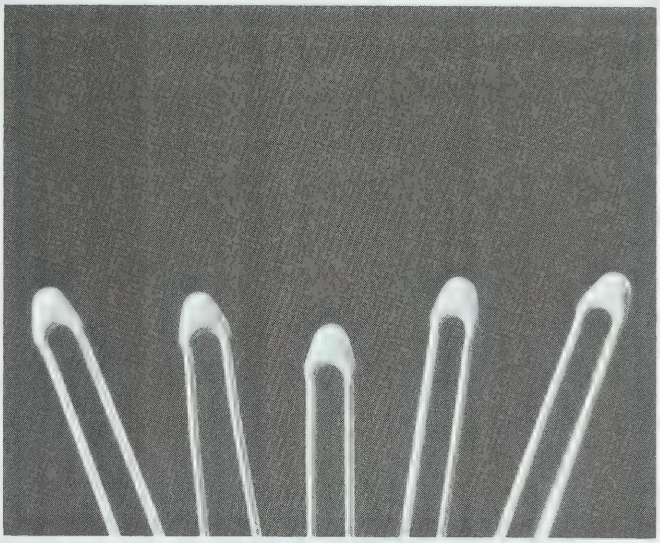
8 Non-Linear Resistors

SERIES 645-0

NTC Thermistors for Temperature Measurements

DESCRIPTION

The Series 645-0 NTC Thermistor was developed as a general purpose temperature sensor. It is a radial leaded, coated disc with solid tinned copper leads.



ELECTRICAL SPECIFICATIONS

Dissipation .... 100 mW maximum
Dissipation Factor .... 6.6 mW/°C
Operating Temperature ...... −40°C to +150°C
Thermal Time Constant ..... Approx. 8.5 seconds in still air
..... Approx 1.15 seconds in liquid

MECHANICAL DATA

All Dimensions in Inches (mm)

Weight
Approx 0.22 grams

Mounting
In any position by soldering

Robustness of Terminations
Tensile Strength: 2.25 lb (10 N)
Bending: 1.12 lb (5 N)

Soldering
Solderability: Max. 240°C 4 seconds maximum
Resistance to Heat: 260°C ±5°C 10 sec ±1 sec.

Impact
Free Fall 39.4″ (1000 M)

Non Flammable

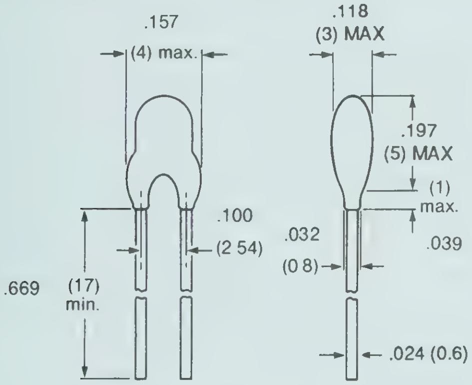


Fig. 1 0,1 W types.

ALL DIMENSIONS IN INCHES (MM)

8 Non-Linear Resistors

SERIES 645-0

Temperature	Ratio R_T/R_{25}	Resistance Deviation due to β Tolerance	Temperature Coefficient	Resistance (kohm) for types 2322-640			
°C		%	%/°C	0.502	0.602	0.802	0.103
−40	32.84	2.65	6.57	164.2	197.0	262.7	328.4
−35	23.77						
−30	17.39	2.16	6.15	86.95	104.3	139.1	173.9
−25	12.85						
−20	9.589	1.71	5.76	47.95	57.53	76.71	95.89
−15	7.223						
−10	5.489	1.29	5.40	27.45	32.93	43.91	54.89
−5	4.207						
0	3.251	0.89	5.08	16.26	19.51	26.01	32.51
5	2.531						
10	1.986	0.52	4.78	9.930	11.92	15.88	19.86
15	1.569						
20	1.249	0.17	4.50	6.245	7.494	9.992	12.49
25	1.000	0.0	4.37	5.000	6.000	8.000	10.00
30	0.8060	0.16	4.25	4.030	4.836	6.448	8.060
35	0.6536						
40	0.5331	0.47	4.02	2.666	3.199	4.265	5.331
45	0.4372						
50	0.3606	0.77	3.80	1.803	2.164	2.885	3.606
55	0.2989						
60	0.2490	1.05	3.60	1.245	1.494	1.992	2.490
65	0.2085						
70	0.1753	1.31	3.42	0.8765	1.052	1.402	1.753
75	0.1481						
80	0.1256	1.57	3.25	0.6280	0.7536	1.005	1.256
85	0.1070						
90	0.09155	1.81	3.09	0.4578	0.5493	0.7324	0.9155
95	0.07861						
100	0.06775	2.04	2.94	0.3388	0.4065	0.5420	0.6775
105	0.05860						
110	0.05086	2.26	2.80	0.2543	0.3052	0.4069	0.5086
115	0.04429						
120	0.03870	2.47	2.67	0.1935	0.2322	0.3096	0.3870
125	0.03392						
130	0.02982	2.67	2.55	0.1491	0.1789	0.2386	0.2982
135	0.02629						
140	0.02324	2.86	2.43	0.1162	0.1394	0.1859	0.2324
145	0.02061						
150	0.01832	3.05	2.33	0.0916	0.1099	0.1466	0.1832

(1) Replace dot in code number (9th digit) by: 2 for a tolerance of 10%
3 for a tolerance of 5%

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INTRODUCTION

Positive Temperature Coefficient (PTC) thermistors are resistors with a high positive temperature coefficient of resistance. They differ from NTC thermistors in the following aspects:

- The temperature coefficient of a PTC thermistor is positive only *between certain temperatures,* outside this range the temperature coefficient is either zero or negative.
- The absolute value of the temperature coefficient of PTC thermistors is usually much higher than that of NTC thermistors.

PTC thermistors are used as current limiters, temperature sensors and protectors against overheating in equipment such as electric motors. They are also used as level indicators, time delay devices, thermostats, compensation resistors, etc. See 'Applications.'

PTC thermistors are prepared from $BaTiO_3$, or solid solutions of $SrTiO_3$ or $PbTiO_3$ in a similar way as NTC thermistors. Extra electrons on the Ti-ions are created by the introduction of foreign ions having a different valency. In these compounds there are two possibilities: substitution of trivalent ions like La^{3+} or Bi^{3+} for Ba^{3+} or substitution of pentavalent ions like Sb^{5+} for Nb^{5+} for Ti. Both methods lead to identical results. If prepared in the absence of oxygen, these semiconductors have a weakly negative temperature coefficient. A strong positive temperature coefficient is obtained by firing the ceramic samples in an oxygen-rich atmosphere. This is caused by the penetration of oxygen along pores and crystal boundaries during cooling after the firing process. The oxygen atoms, absorbed on the crystal surfaces attract electrons from a thin zone of the semiconducting crystals. In this way electrical potential barriers are formed consisting of a negative surface charge with, on both sides, thin layers having a positive space charge resulting from the now uncompensated foreign ions. These barriers cause an extra resistance of the thermistor.

$$R_b \propto \frac{1}{a} e^{eV_b/kT} \quad (\propto = \text{directly proportional to})$$

Here 'a' represents the size of the crystallites, thus $\frac{1}{a}$ is the number of barriers per unit length of the thermistor. V_b represents the electrical potential of the barriers. As V_b is inversely proportional to the value of the dielectric constant of the crystals it is clear that R_b is extremely sensitive to variations of the dielectric constant. Such a variability of the dielectric constant is a special property of materials with a ferroelectric nature like $BaTiO_3$ and its solid solutions. Above their ferroelectric Curie temperature θ the relative dielectric constant decreases with temperature according to

$$\epsilon r = \frac{C}{T-\theta}$$

where C has a value of approximately 10^5 K. As a result the resistivity increases steeply just above the Curie temperature. Below the Curie temperature the barriers are weak or absent, partly as a result of the high effective dielectric constant of $BaTiO_3$ in strong fields and partly as a result of the spontaneous polarization of the crystals which may compensate the boundary charges.

At very high temperatures the electrons captured at the boundaries are gradually liberated, causing the potential barriers to decrease in strength. This means that the PTC loses its properties and may eventually act as an NTC if the temperature becomes too high. Therefore the applications of PTC thermistors are restricted by a certain temperature limit.

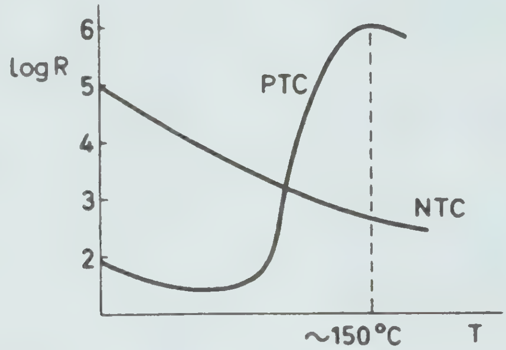
PTC Thermistors

ELECTRICAL PROPERTIES

Resistance/Temperature Characteristics

Figure 1 shows typical resistance/temperature characteristics of an NTC and a PTC thermistor.

Fig. 1.



Voltage/Current Characteristics

Static voltage/current characteristics show the current limiting ability of PTC thermistors. Up to a certain voltage the V/I characteristic follows Ohm's law, but the resistance increases when the PTC is heated so much by the current it is carrying that its temperature reaches the switch temperature. See Fig. 2. Of course the V/I characteristic depends on the ambient temperature and on the heat transfer coefficient to the ambience. In Fig. 2 the characteristic is plotted on a linear scale. In practice, however logarithmic scales are used more often, see Fig. 3. PTC thermistors show some voltage dependency. At higher voltages the resistance is somewhat lower than expected. It is possible to calculate accurately the top of the V/I characteristic if the R/T characteristic and the dissipation constant are known:

The power dissipation is: $P = I^2R$

Thus a small increase in P: $\Delta P = 2\,IR\Delta I + I^2\Delta R$

At the top of the V/I curve $\Delta I_p = 0$, thus:

$$\Delta P_p = I_p^2\,\Delta R_p$$

(p indicates that the values are taken at the top of the V/I characteristic).

Also $\Delta P = D\Delta T$, thus:

$$\Delta P_p = D\Delta T_p = I_p^2\,\Delta R_p$$

or

$$\frac{\Delta T_p}{\Delta R_p} \cdot D = I_p^2$$

8 Non-Linear Resistors

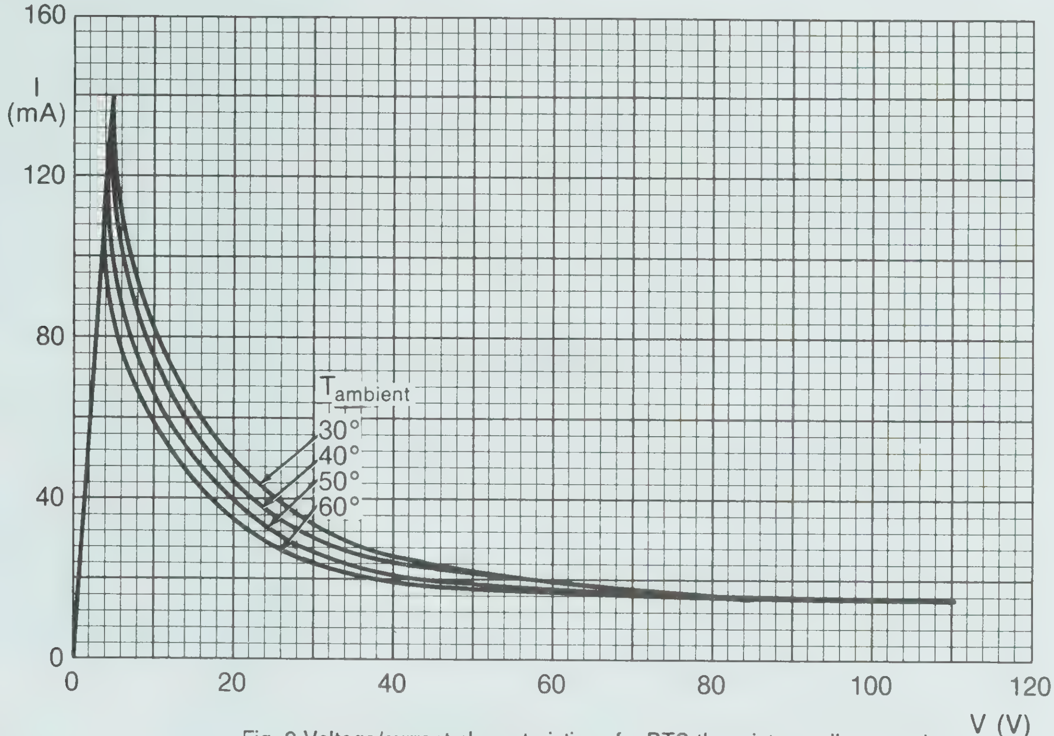


Fig. 2 Voltage/current characteristics of a PTC thermistor on linear scale, with ambient temperature as a parameter.

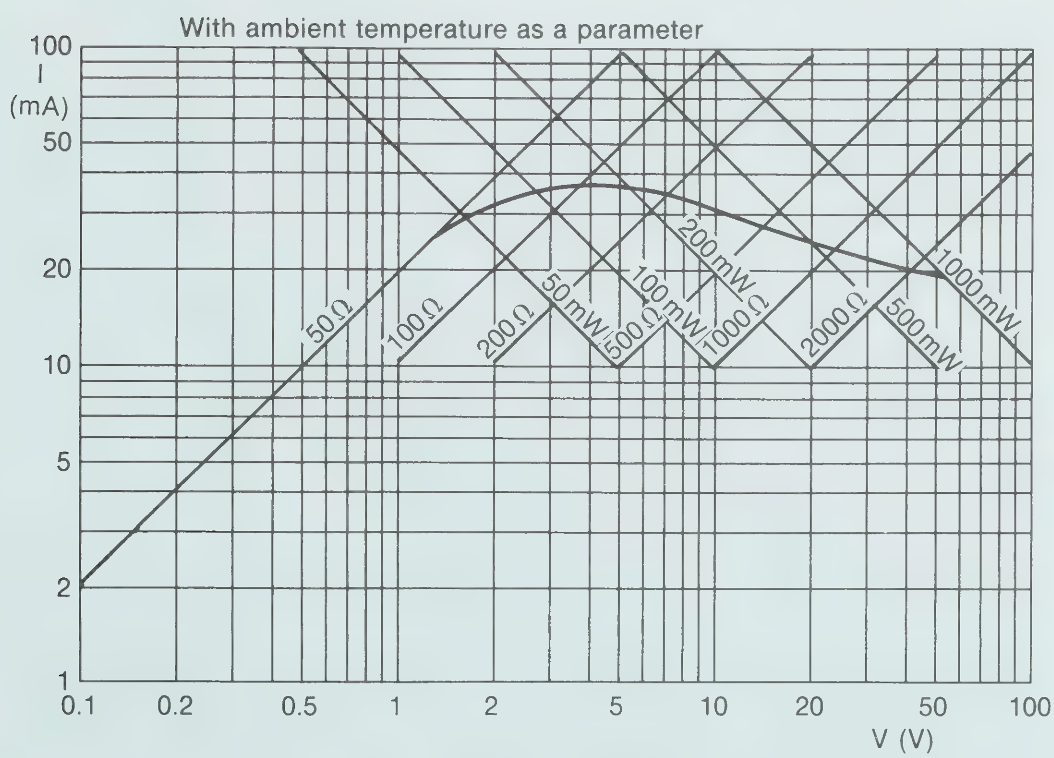


Fig. 3 Voltage/current characteristic on logarithmic scale.

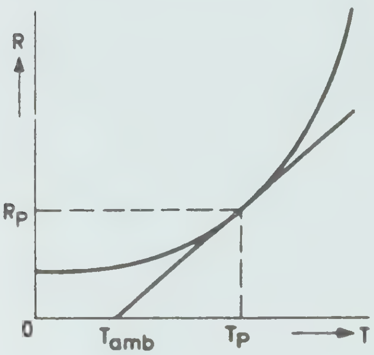


Fig. 4 Part of the resistance/temperature characteristic on a linear scale.

From Fig. 4:

$$\frac{\triangle T_p}{\triangle R_p} = \frac{T_p - T_{amb}}{R_p}$$

so

$$I_p = \sqrt{\frac{D(T_p - T_{amb})}{R_p}}$$

For given ambient temperature (T_{amb}) and D, R_p and T_p can easily be found; see Fig. 4.

The calculation shows that if D is increased n times (e.g. by a heatsink, or ambience with better heat conductivity) I_p increases $\sqrt{n}$ times.

PTC Thermistor In Series With A Load

From the voltage/current characteristic it can be shown that because of the non-linearity of the PTC-curve three working points are possible when a load R is connected in series with the PTC. See Fig. 5. The characteristic of the load is a straight line intersecting the voltage co-ordinate at V_a, the supply voltage. P_1 and P_2 are stable working points; P_3 is unstable.

When the voltage V_a is applied to the series connection, equilibrium will be reached at P_1, a point with a relatively high current. P_2 can only be reached when the top of the V/I curve comes below the load characteristic. This may happen in the following cases:

- V_a increases, see Fig. 6;
- the ambient temperature increases, see Fig. 7;
- the load resistance decreases, see Fig. 8.

The PTC thermistor is thus an excellent protector, limiting the load to a safe value if supply voltage, temperature or current exceeds a critical value.

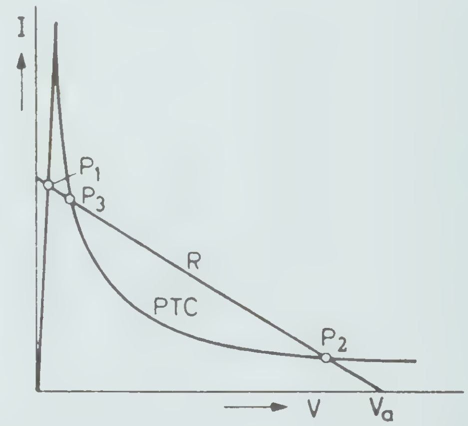


Fig. 5 PTC thermistor in series with a load showing the possible working points.

8

Non-Linear Resistors

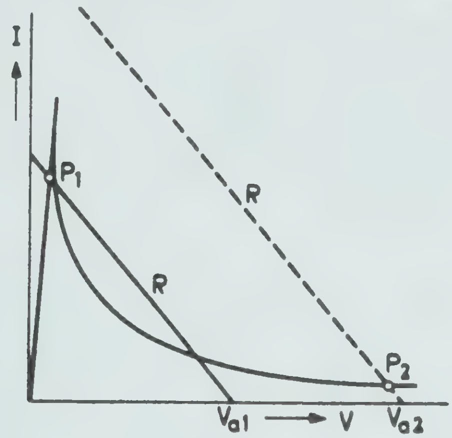


Fig. 6 PTC thermistor in Series with a load showing the influence of the supply voltage Va

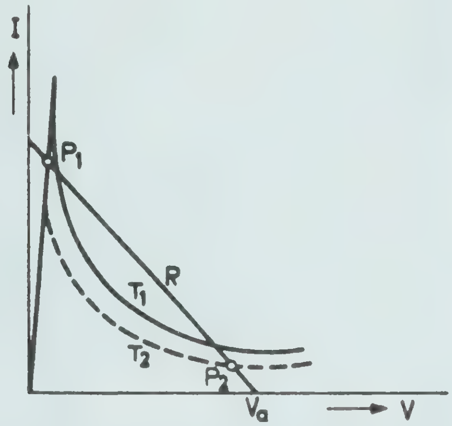


Fig. 7 PTC thermistor in Series with a load showing the influence of ambient temperature

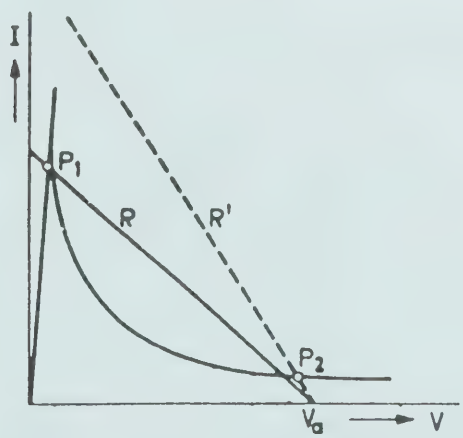


Fig. 8 PTC thermistor in Series with a load showing the influence of the load resistance

PTC Thermistors

Current/Time Characteristics

If a PTC thermistor is connected in series with a resistance of such a value that the top of the V/I curve lies under the load line, the PTC will heat up till the stable working point P_2 is reached (Fig. 9). The time it takes to reach this point depends very much on the value of the load R (Fig. 10) and the ambient temperature.

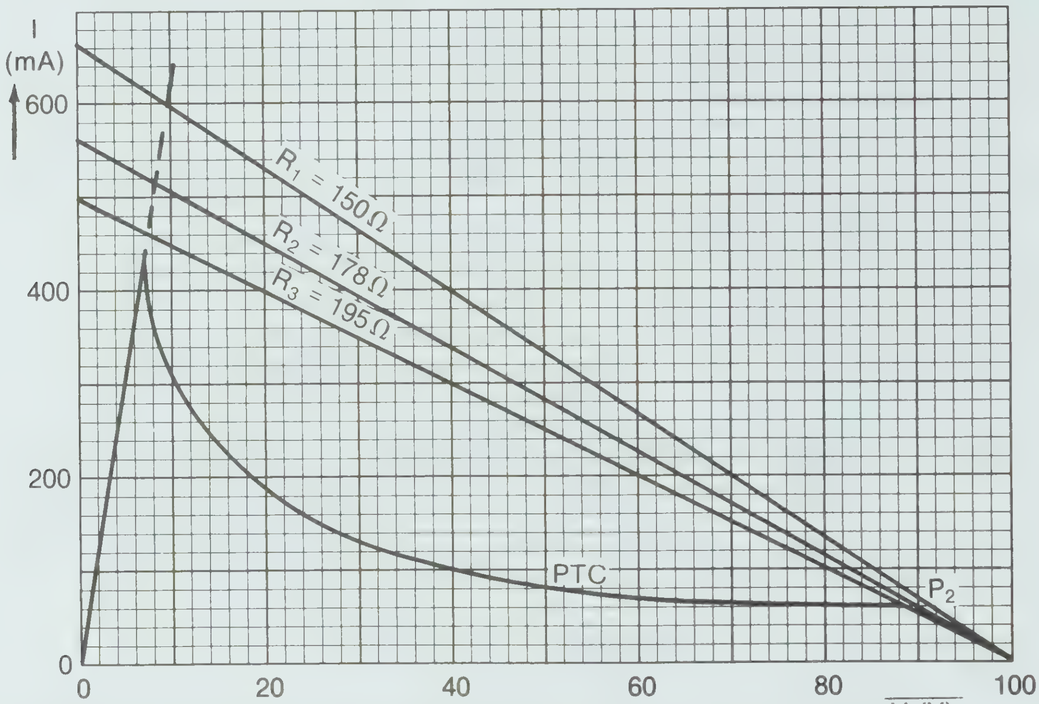


Fig. 9 PTC thermistors in series with different resistors.

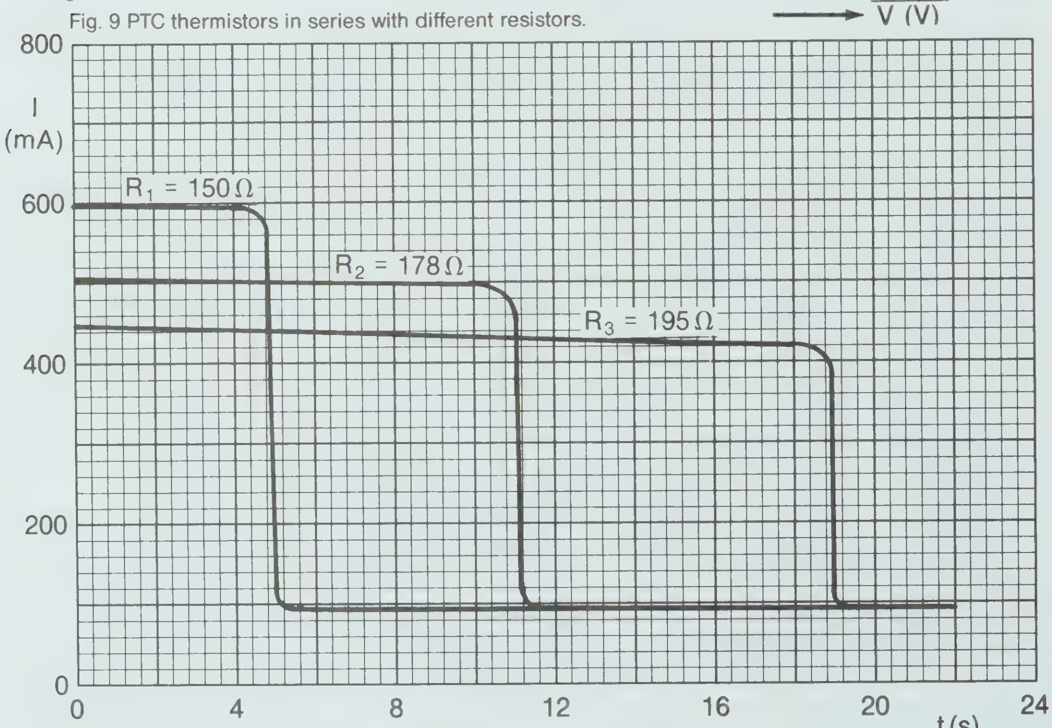


Fig. 10 Current/time characteristics showing the influence of the load.

8 Non-Linear Resistors

EXPLANATION OF TERMS

Switch temperatures (T_s)

The switch temperature T_s is the higher of the two temperatures at which the resistance R_s is twice the minimum resistance R_{min} (see Fig. 11).

So, at $T_s > T_{Rmin}$: $R_s = 2\ R_{min}$.

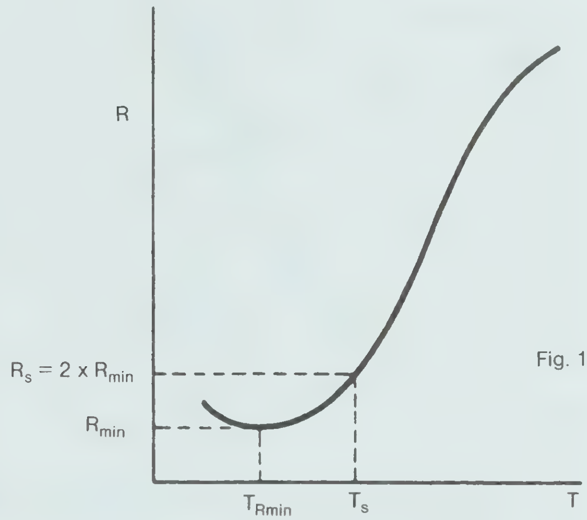


Fig. 11.

Tempertature coefficient (α)

The temperature coefficient $\alpha = \frac{1}{R}\ \frac{dR}{dT}$.

For R-T curves plotted on a long R-lin T scale:

$$\alpha = \frac{d\ \ln R}{dT} = \frac{1}{0.4343} \cdot \frac{d\ \log R}{dT}$$

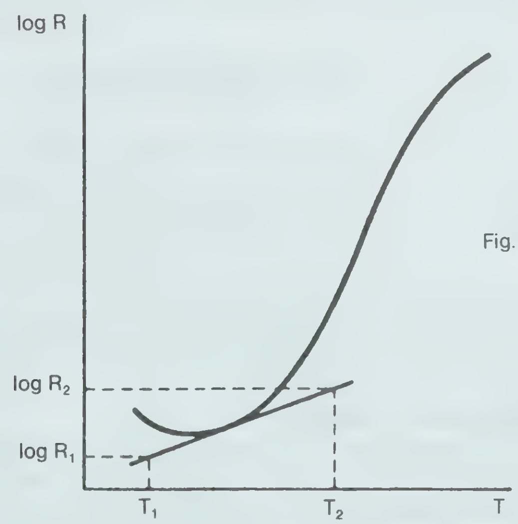


Fig. 12.

α can be calculated from

$$\alpha = \frac{100}{0.4343} \cdot \frac{\log R_2 - R_1}{T_2 - T_1} \quad \%/°C$$

where R_1 and R_2 are points on the tangent and T_1 and T_2 are the corresponding temperatures.

In the data sheets the maximum temperature coefficient is given, this is the α measured at the point of inflection of the log R-lin T characteristic, i.e. the point where $\frac{d^2 \log R}{dT^2} = 0$, see Fig. 13.

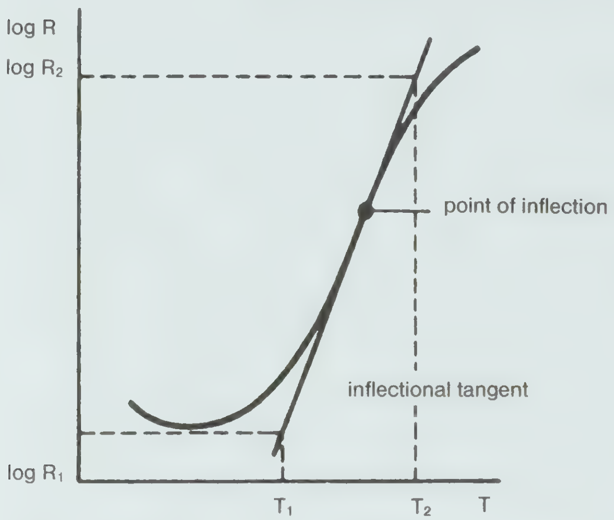


Fig. 13.

When one resistance decade is taken ($R_2 = 10R_1$) the formula reduces to

$$\alpha = \frac{100}{0,4343} \cdot \frac{1}{T_2 - T_1} \text{ \%/°C}$$

Thermal time constant (τ)

The thermal time constant represents the time required for a thermistor to change 63.2% of the total difference between its initial and final body temperatures when subjected to a step function change in temperature under zero-power conditions.

The τ given in the data is found as follows (for $T_S > 25°C$):

Measure T_1, the temperature of the PTC at V_{max}, at an ambient temperature of $T_O = 25°C$; T_S is known, so τ can be calculated from:

$$\tau = \frac{t}{\ln (T_1 - T_O)/(T_S - T_O)},$$

where t is the time required for cooling the PTC from T_1 to T_S in still air at 25°C.

Voltage dependence

PTC thermistors show a voltage dependence. This effect can be explained with the aid of a parallel connection of an "ideal PTC" having no voltage dependence and an "ideal VDR" for which the relation between voltage and currents is:

$V = C.I\beta$

See Fig. 14.

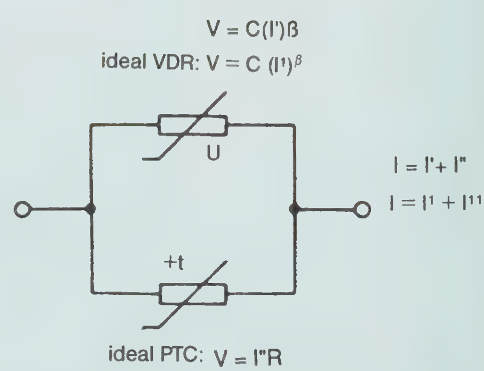


Fig. 14

Plotted on log I-log V scale at an arbitrary constant temperature the ideal PTC and the ideal VDR characteristics are straight lines, see Fig. 15.

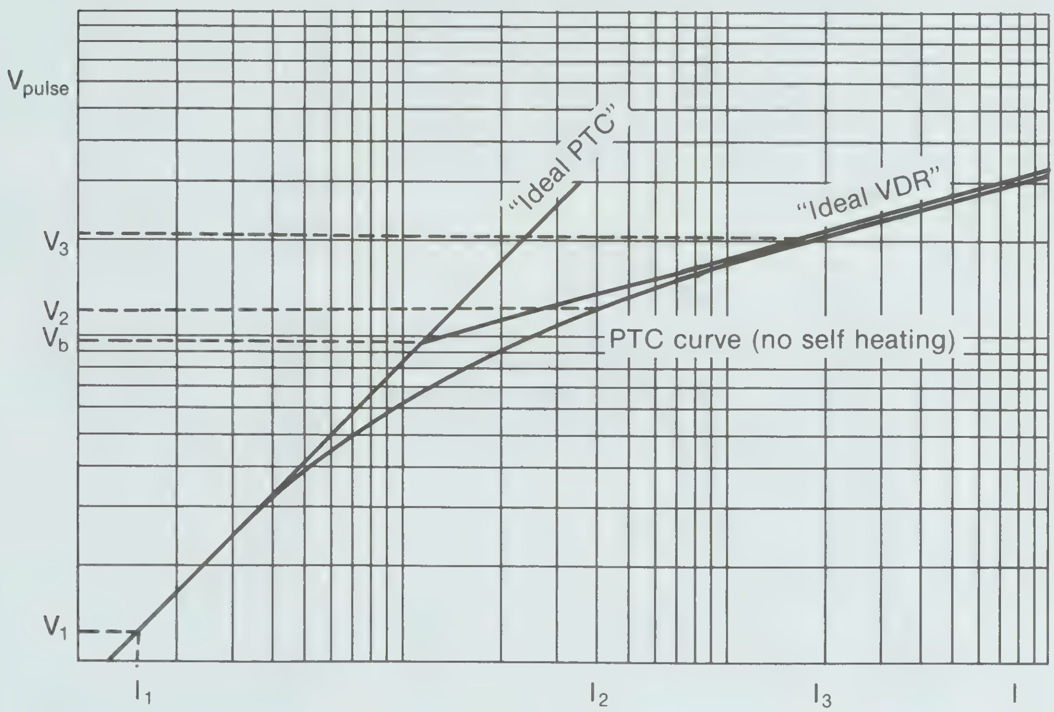


Fig. 15

These lines coincide with the PTC curve (measured under pulse conditions to avoid internal heating) at low voltages where the ohmic behaviour is the deciding factor, and at high voltages where the VDR effect becomes more significant.

Two aspects of the voltage dependence are specified in the data sheets:

Balance voltage (V_b)
Where the two straight lines intersect, the current through the ideal PTC is equal to the current through the ideal VDR. The voltage at which this occurs is called the balance voltage V_b and is specified at a certain temperature.

Voltage dependence (β)
The β of the ideal VDR is a measure of the voltage dependence of the PTC and can be calculated using the formula:

$$\beta = \frac{\log V_3/V_2}{\log (I_3 - V_3/R)/(I_2 - V_2/R)}$$

where V_3 and V_2 are pulse voltages $> V_b$ and $R = \frac{V_1}{I_1}$, measured at $V_1 \leq 1.5$ V (d.c.).

β is also specified at a certain temperature.

V_b and β are useful parameters for estimating the voltage dependence of a particular PTC thermistor.

PTC Thermistors

HOW TO MEASURE PTC THERMISTORS

As PTC thermistors often show a very high temperature coefficient especially at high temperatures, measurements at these high temperatures must be carried out with particular care. Even an error of 0.1°C can give an error in resistance of a few percent. Specially calibrated thermometers have to be used. Stem correction has to be applied; deviatons of more than 0.1°C may result if it is not used. The stem correction formula for fluid thermometers is:

$$T_c = T_o + F \cdot L\,(T_o - T_m),$$

where: T_c = corrected temperature;
T_o = observed temperature;
T_m = mean temperature of exposed stem;
L = length of the exposed column in K above the surface of the substance whose temperature is being determined;
F = correction factor.

F is approximately 0.00016 for a mercury thermometer.

For example with T_o = 110°C, T_m = 70°C and L = 50 K: T_c = 110.32°C, thus without stem correction an error of more than 0.3°C would have been made. It is also necessary to measure the resistance with a voltage below 2 V in order not to heat the PTC and also to diminish voltage-dependent effects.

Tolerances

The resistances of standard PTC thermistors are specified at

(1) 25°C;
(2) A temperature above the switch temperature.

The switch temperature is also given.

For each standard type tolerances are specified for R_{25} and the high-temperature resistance. The tolerance on switch temperature is not specified; normally it is only a few °C.

Special types are often specified according to the requirements for the particular application. The PTC thermistors for motor control, for instance, can be specified at a high temperature with a rather close tolerance, while the tolerance below the switch temperature, being less important, is much greater. PTC thermistors for current limiting applications are in most cases specified in terms of voltage and current.

It will be clear that the specification and the tolerances of PTC thermistors depend on the application, and are not limited to the standard range published in this book.

APPLICATIONS

The applications of PTC thermistors can be classified in two main groups:

- Applications where the temperature of the PTC is primary determined by the temperature of the ambient medium.
- Applications where the temperature of the PTC is primary determined by the current through the PTC thermistor.

The first group comprises applications such as temperature-measurement and control and circuits for protection against excessive temperatures (e.g. motor protection).

The second group includes applications such as current stabilization and current sensitive switching or overload protection, relay retardation, fluid-level indication and circuits for protection against over-voltages and short circuits. Also heating applications.

Advice

Do not apply a voltage above V_{max} to the PTC, since this may destroy the thermistor.

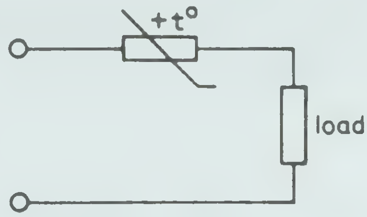
Do not connect PTC thermistors in series in order to obtain higher voltages or wattages: this may cause one PTC to heat up faster than the other(s) resulting in too high a voltage across this particular PTC.

If special PTC characteristics are required which cannot be found in this book please specify your requirements as they can perhaps be fulfilled by one of our non-listed types.

Application Examples

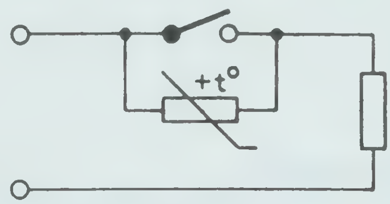
Protection against over-load or current sensitive switching

As soon as the current increases the PTC limits it to a safe value.



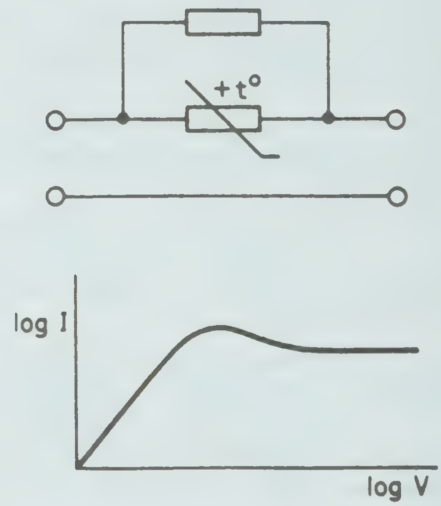
Spark suppression

A PTC across the switch acts as a spark suppressor. When the switch opens the low resistance of the cold PTC prevents sparking.

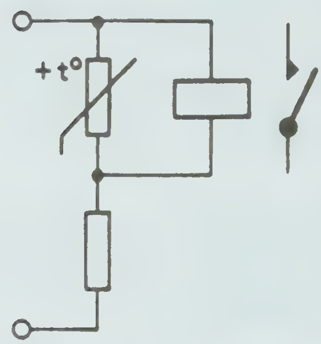


PTC Thermistors

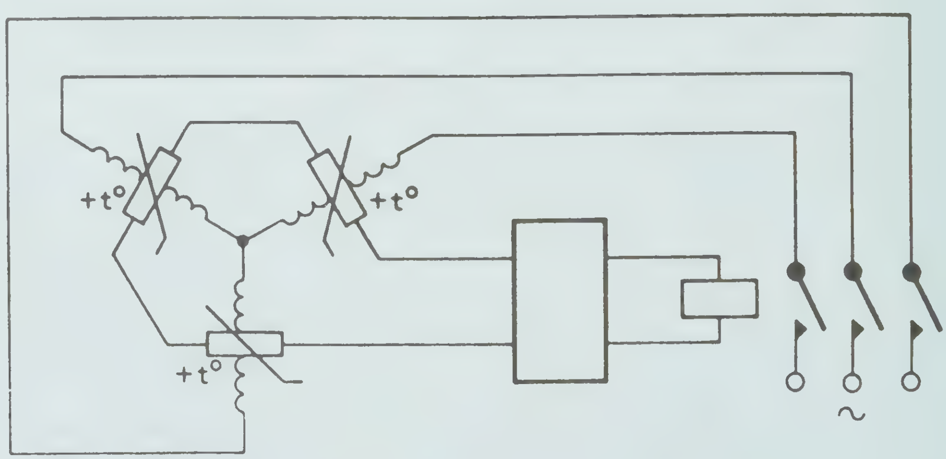
Current stabilization
By using a parallel resistor a current stabilization circuit is obtained that compensates slowly varying supply voltages.

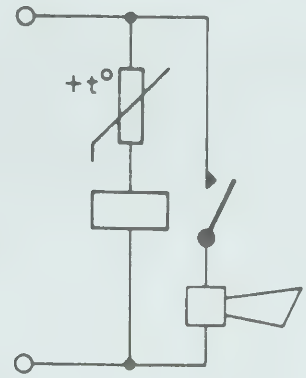


Delaying action relays
A certain time after applying the voltage the relay is activated.

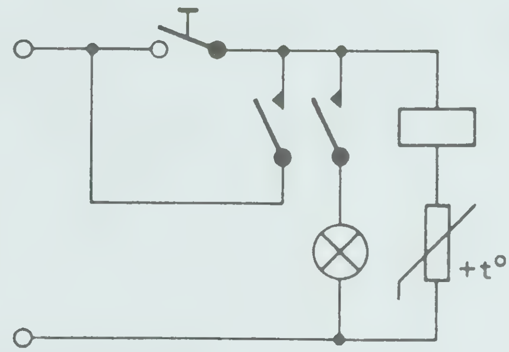


Temperature protection of electric motors
As soon as one or more windings become too hot the motor is switched-off.

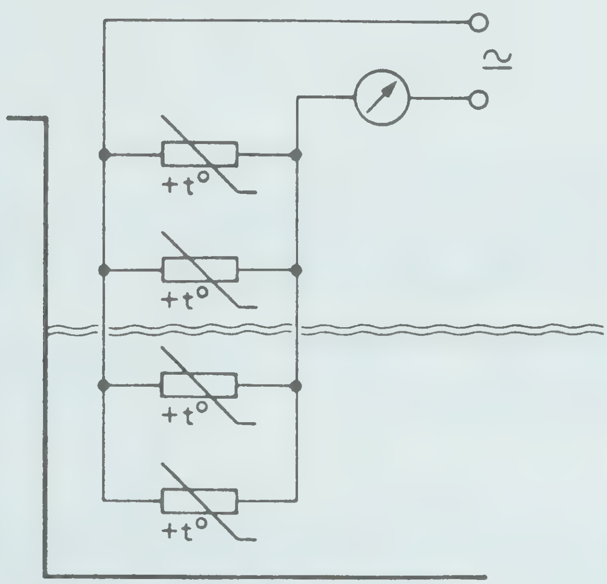




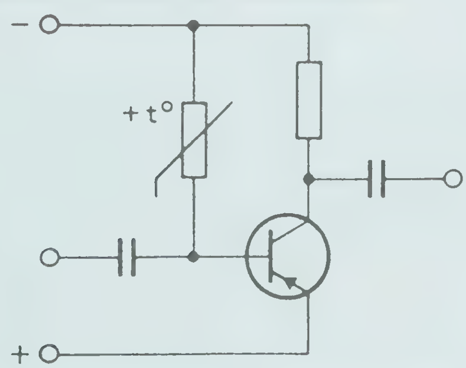
Alarm installation
The PTC reacts on ambient temperature (too low or too high).



Time delay circuit
When the button is pressed the relay is activated and the lamp lights up. After some time the relay falls off due to the increase in resistance of the PTC.



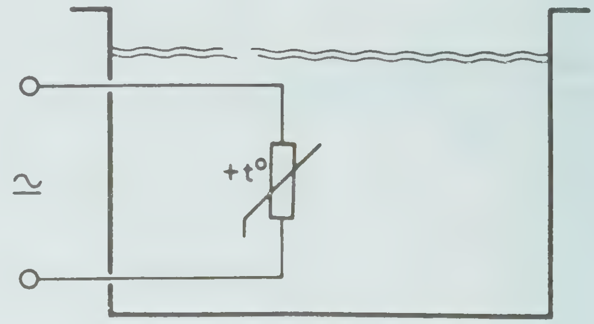
Liquid-level indication
The PTC thermistors above the fluid-level will be heated to a temperature above T_{switch}. When immersed they are cooled so that their resistance reduces.

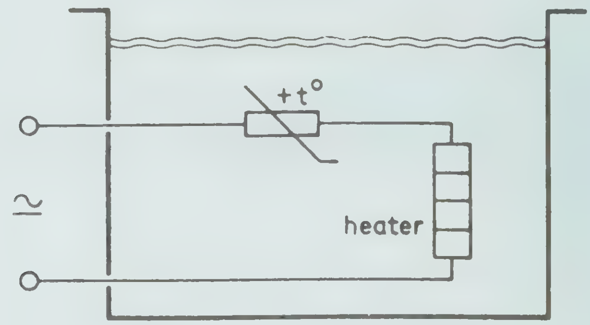


Temperature compensation of transistor circuits

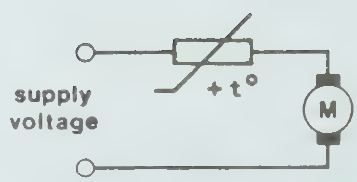
PTC Thermistors

Thermostatically-controlled heating circuits
Two principal circuits are possible. In the first circuit the PTC thermistor acts as a control element and as a heater at the same time, while in the second circuit it functions only as a control element.

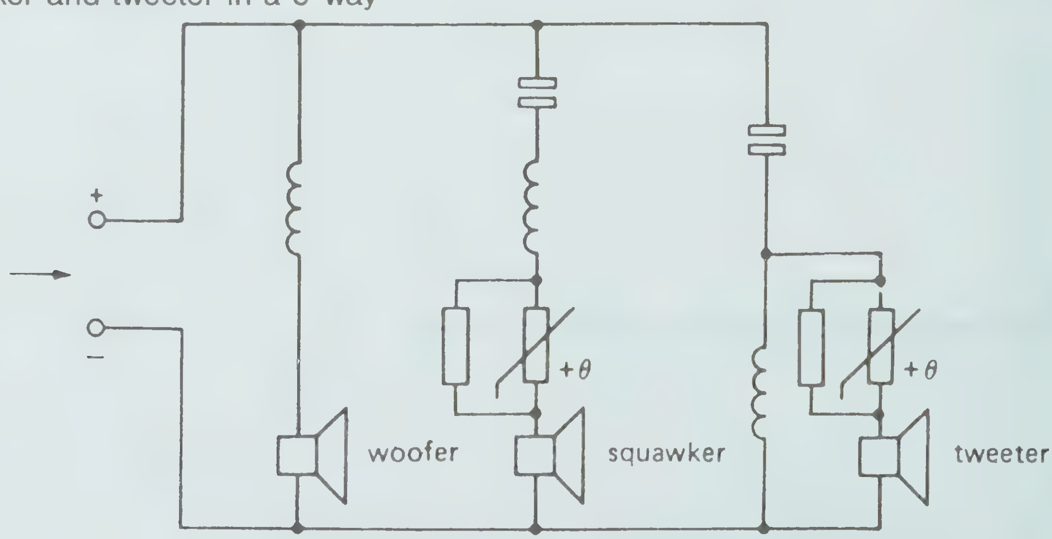




Protection of a stalled electric motor against overheating.
The increased current heats the PTC to its switch temperature. As a result the total dissipated power is reduced to a safe value.



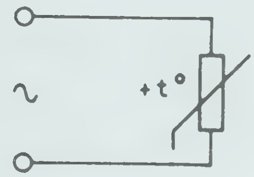
Loudspeaker protection
Protection of squawker and tweeter in a 3-way loudspeaker system.



8 Non-Linear Resistors

Heading

Heating
As used in hair curlers, heating plates.



Ceramic elements with a positive temperature coefficient are particularly suitable for heating elements:

- they are self-regulating, so don't need thermostats to limit or stabilize temperature,
- they warm-up fast,
- the dissipated power is virtually independent of supply voltage.

The behaviour of PTC heating elements cannot easily be concluded from the R/T or V/I curves, because the temperature of the element is not homogenous during operation. In addition, the mounting has considerable influence on this behaviour which includes the dissipated power, the relevant temperature and the extent of the power regulation.

The uneven temperature profile across an element is due to the increased cooling of the faces of the element. This means that the inner temperature is usually higher than T_s whereas the upper and bottom temperature is lower than T_s.

Fig. 1 shows a typical temperature profile across a heating element.

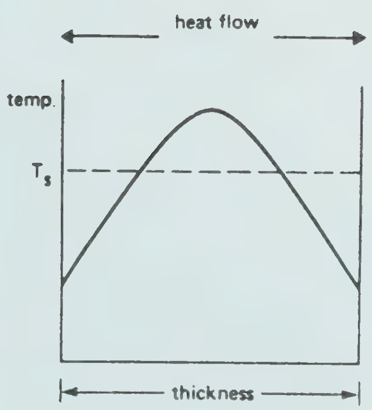


Fig. 1.

The inner part of the element is high-ohmic and there the dissipation is taking place. Consequently, heat transfer is from the inside to the faces of the element.

It is possible to make a thermal equivalent circuit of a PTC heating system. Such a circuit can be considered, also for calculations, as an electric simulator, so that an analysis of the system can be realized. Table 1 shows the analogy between electrical and thermal parameters. Fig. 2 shows a simplified thermal equivalent circuit.

PTC Thermistors

Table 1

	electrical	thermal
resistance	R (Ω)	R_{th} (K/W)
voltage	V (V)	T (°C)
current	I (A)	P (W)
capacitance	C (F)	H (J/K)
Ωs law	$R = \frac{V}{I}$	$R_{th} = \frac{T}{P}$
	$V = \frac{1}{C} \int Idt$	$T = \frac{1}{H} \int Pdt$

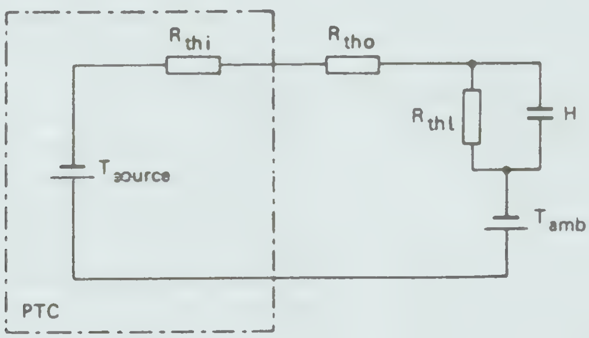


Fig. 2 Thermal equivalent circuit.

Using this thermal equivalent circuit, you can:

- do simple calculations on the heating system (because of the resemblance with electrical circuits)
- acquire a good insight in the operation of a PTC heater
- predict the influence of different parameters.

The power in stabilized conditions can be calculated from:

$$P = \frac{T_{source} - T_{amb}}{R_{thi} + R_{tho} + R_{thl}} \text{ (W)}$$

The temperature of the object is:

$$T_l = \frac{R_{thl}}{R_{thi} + R_{tho} + R_{thl}} \times [T_{source} - T_{amb}] + T_{amb} \text{ (°C)}$$

The time constant of the system is:

$$\tau = H \times \frac{R_{thl} \times (R_{thi} + R_{tho})}{R_{thl} + R_{thi} + R_{tho}} \text{ (s)}$$

- T_{source} (°C) is mainly determined by T_s. The value is approx. $T_s + 25$
- T_{amb} (°C) is ambient temperature
- R_{thi} is the internal thermal resistance of the PTC. This value is mainly determined by:
  - a) dimensions of the ceramic
  - b) thermal conductivity of the ceramic (λ = 2.4 W/mK)
- R_{tho} is the thermal resistance between the surface of the ceramic and the object to the heated and is computed from various parameters:
  - a) thermal resistance between ceramic and isolator
  - b) thermal resistance of the isolator
  - c) thermal resistance between isolator and object to be heated
- R_{thl} is the thermal resistance of the object to be heated
- H is the thermal capacity of the object

For optimum heating performance, the R_{tho} must be kept as low as possible.

For the insulated heating element range 2322 680 0 . . . the total thermal resistance (R_{thi} + R_{tho}) is approximately 2.5°C, when properly mounted.

Temperature/power curve

Another presentation, derived from the thermal equivalent circuit is a graphical one; see Fig. 3.

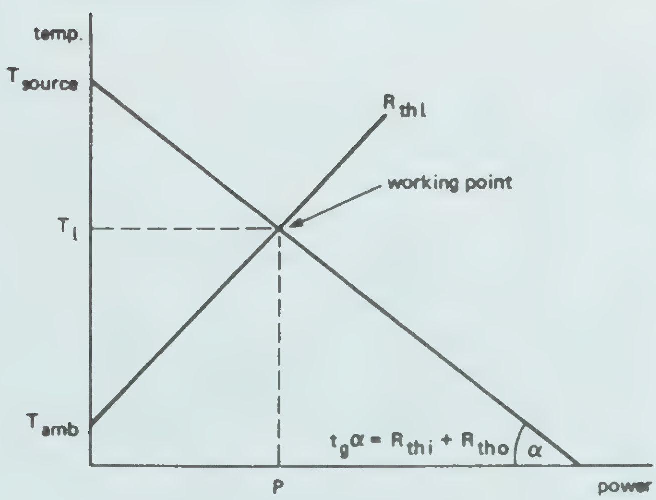


Fig. 3.

Influence of ambient temperature, load and mounting on heating performance

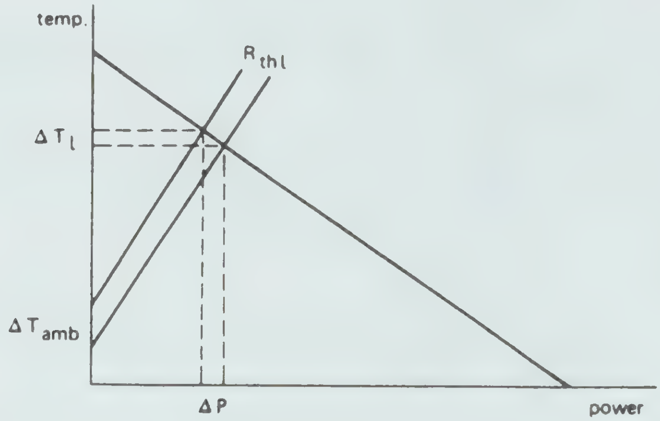


Fig. 4 Influence of ambient temperature.

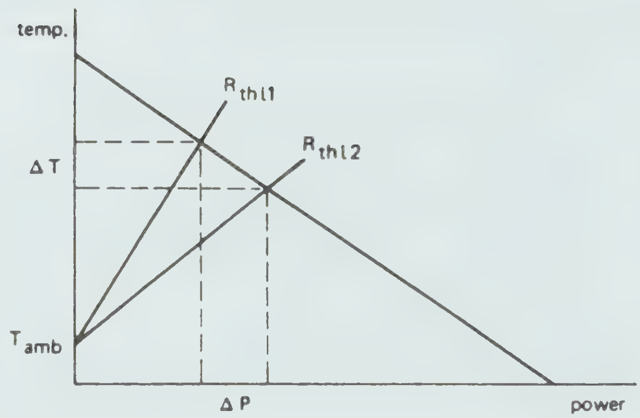


Fig. 5 Influence of load variation.

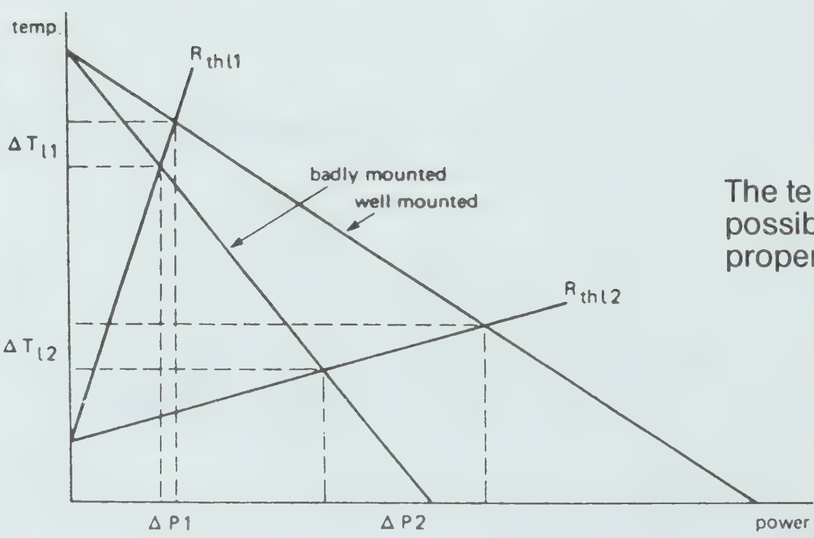


Fig. 6 Influence of mounting method.

The temperature power curve must be as flat as possible for the best temperature stabilization properties (R_{tho} as low as possible).

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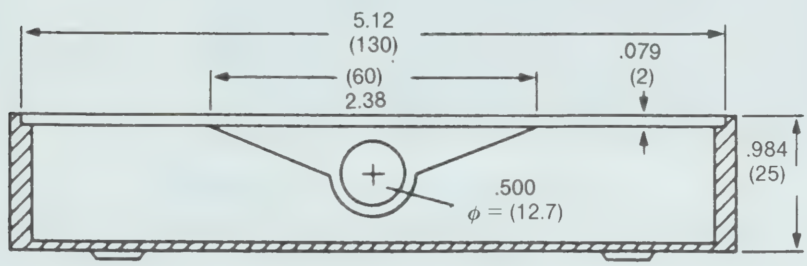
When a heating element such as 2322 680 04022 is mounted in an aperture which is too large, the thermal coupling will be poor. This results in a high value is R_{tho}.

When a heating element is not heavily loaded, e.g. in a hair curler (represented by R_{thl1}) the influence of poor mounting is not so severe as for a system in which the heating element is heavily loaded, e.g. in a pre-heating system for an oil burner (represented by R_{thl2}).

Example

Heating plate using PTC 2322 680 04022.



Dimensions in Inches (mm) Fig. 7.

The aluminum plate is 5.12 × 5.12 × .079 (130 × 130 × 2). The results are depicted in Fig. 8.

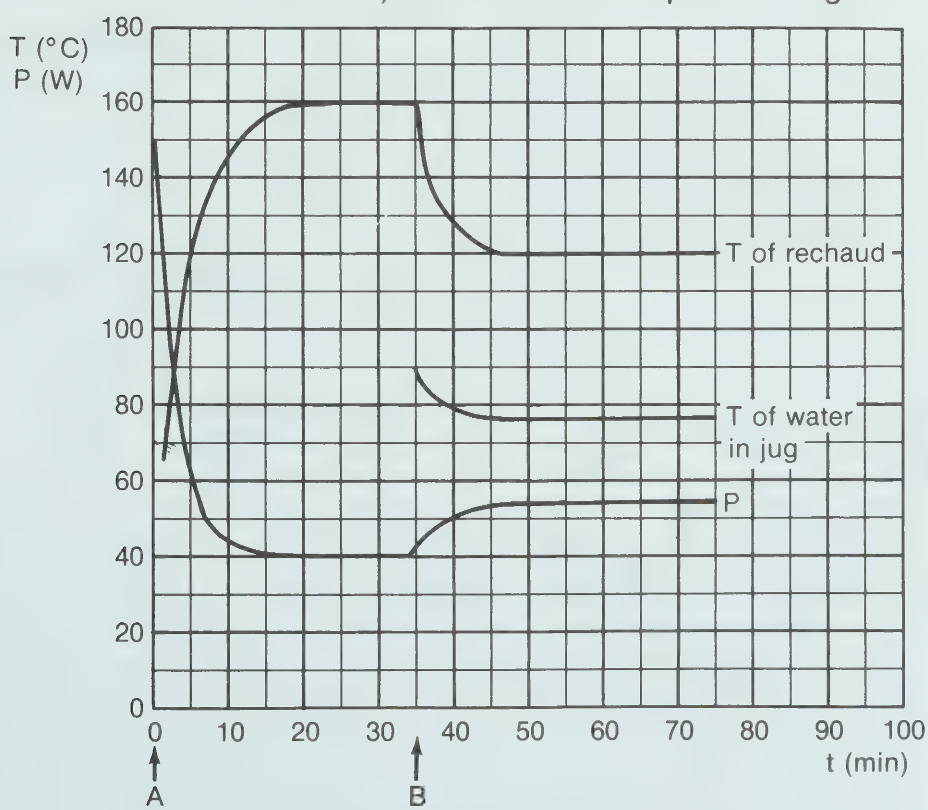


Fig. 8 A = heating plate switched on, unloaded; B = loaded with pyrex water jug containing 1 liter, 90°C; ambient air temperature = 20°C (constant).

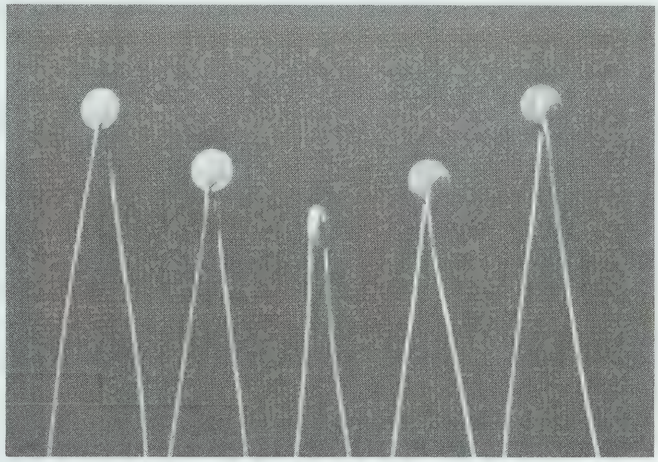
PTC Thermistors

The following data book pages represent "standard" items available. Many "specials" not shown already exist and we are always ready to develop cost effective solutions to your particular requirements. If you can't find what you need or if you have questions regarding any of our VT&S products, contact our factory in Mineral Wells, Texas for application and engineering assistance.

SERIES 660

Disc PTC Thermistors

5% to 40%/°C T. C. of R 50 to 250Ω at 25°C 6° to 105°C Switch Temperature



DESCRIPTION

Series 660 Thermistors span a considerable operational spectrum, in both thermal and electrical domains. It features a low thermal time constant, providing rapid response to electrical and thermal overloads, and subsequent rapid recycling upon recovery.

DESIGN FEATURES

- **Low Time Constant**—18 seconds, average, for rapid response, quick recycling, upon overload or excessive temperature excursion.
- **Wide Operating Temperature Range**—as low as −25°C; as high as 155°C, at zero power. To +55°C at full rated voltage.
- **Six Selectable Switch Temperature Ratings:** +6°, +30°, +50°, +80°, +105°, and +115°C in standard catalog thermistors.
- **Miniature Size**—maximum diameter .236
- **Thermistors are lacquer coated.**

TYPICAL APPLICATIONS

- **Temperature Measurement,** for analog or digital monitoring, recording, and control of equipment and process operational temperatures.
- **Temperature Compensation** in electronic and electrical circuits, electromechanical devices, hermetic sealed components, and instrumentation.
- **Overvoltage and Overcurrent Protection** for light electronic and electrical loads.
- **Ambient Temperature Alarm** for high or low temperatures (outside a selected range) in critical circuitry, components, or processes.

TYPICAL ELECTRICAL CHARACTERISTICS

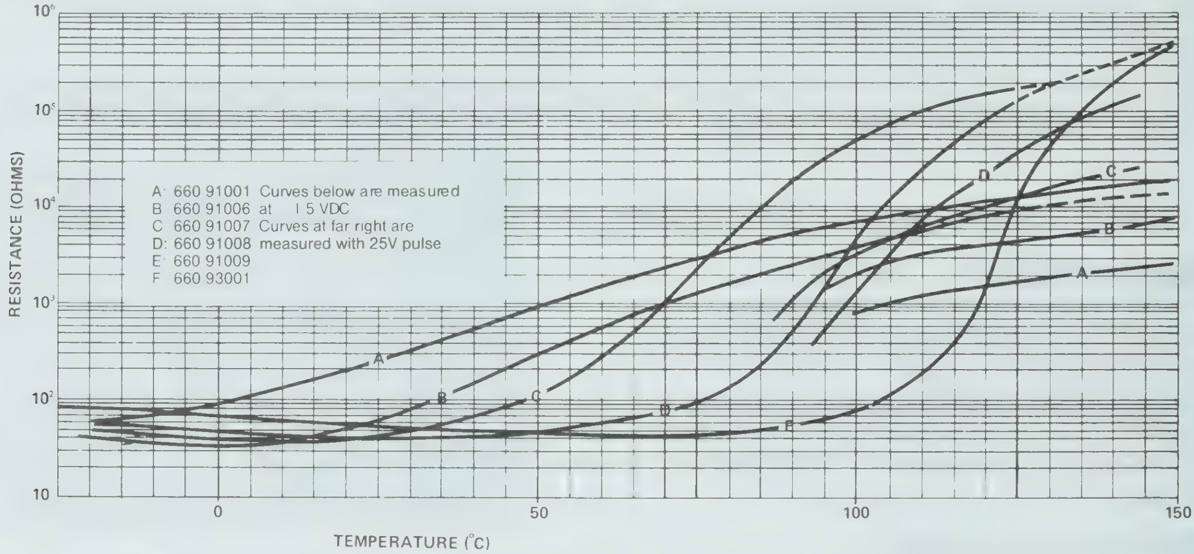
Resistance* at +25°C	Resistance* At Other Temperatures		Switch** Temp. (°C)	Operating† Temperature Range At Zero Power (°C)	Temperature Coefficient (%/°C)	Dissipation Factor (mW/°C)	Thermal Time Constant (sec)	Color Band	Part Number 2322-	Voltage (DC)
	Temp. (°C)	Resistance (Ω)								
250Ω +25%	80°	3.7K 30%	+6°	−25° to +155°	+5%	6	17	none	660-91001	25
60Ω +30%	125°	3-15K	+30°	−25° to +125°	+7%	7	20	Red	660-91006	25
50Ω +30%	125°	100K-500K	+50°	−25° to +125°	+16%	7	18	Orange	660-91007	25
50Ω +30%	125°	50K-500K	+80°	−25° to +125°	+23%	7	18	Yellow	660-91008	25
50Ω +30%	150°	0.1M-1.2M	+105°	−25° to +150°	+40%	7	18	Green	660-91009	25
1125Ω +30%	175°	≤70K	+115°	−25° to +155°	+26%	7	17.5	Brown	660-93001	25

*Measuring voltage: 1.5 V to avoid self heating. **Temperature at which the resistance is twice the minimum resistance.
†+55°C maximum at maximum voltage (25 VDC).

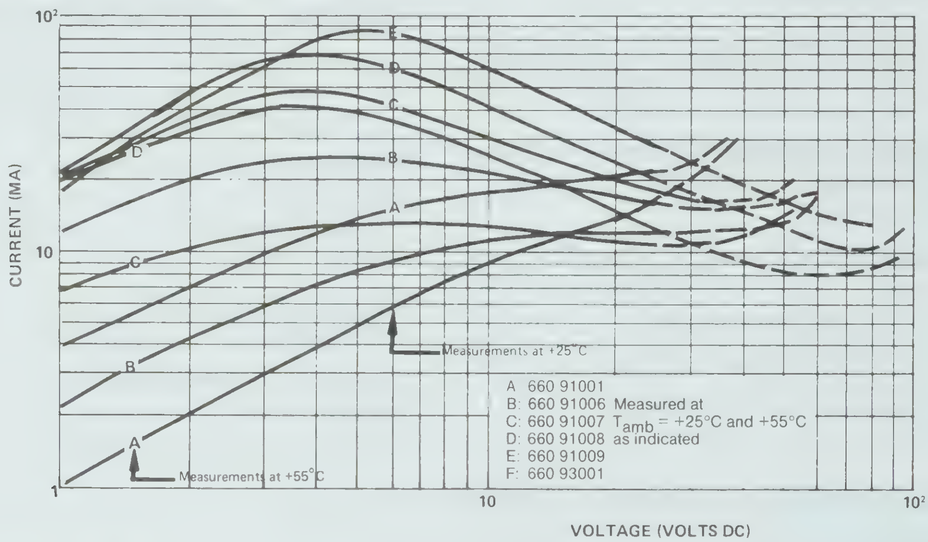
SERIES 660

Disc PTC Thermistors

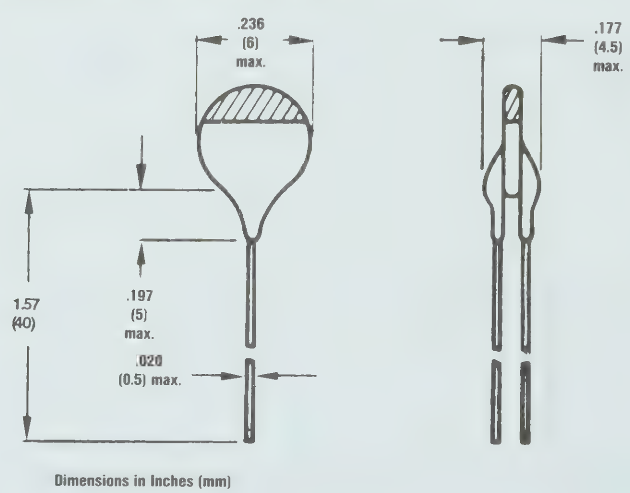
RESISTANCE vs TEMPERATURE



VOLTAGE vs CURRENT



DIMENSIONS AND MARKING



Series 660 thermistors are marked with an identifying color band as indicated at left, and in the table on previous page.

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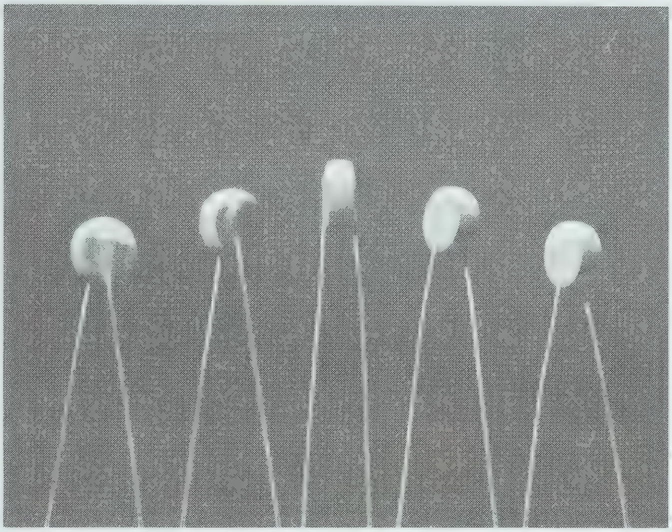
Disc PTC Thermistors

9% to 75%/°C T.C. of R 30 to 50Ω at 25°C +25° to 110°C Switch Temperature 50 Volts maximum



DESCRIPTION

Series 661 Thermistors offer a range of four well defined, switch temperatures between +25°C and +110°C, and are characterized by a relatively steep slope in the resistance/temperature characteristic beyond the switch point, over the normal operating region. This feature, plus the liberal −25°C to +125°C operating temperature range, and the ability to operate at up to 50 Volts DC at temperatures to +55°C, makes the Series particularly well-suited to thermostatic uses, as well as stabilization and equipment-protection applications of many kinds.

DESIGN FEATURES

- **High Temperature Coefficients,** for high sensitivity in the selected operating temperature range.
- **Wide Temperature Range:** −25° to +125°C at zero power; to +55°C at full rated voltage.
- **Wide Range of Switch Temperatures:** +25°, +45°, +80°, or +110°C, for choice of effective region of operation.
- **Thermistors are lacquer coated.**

TYPICAL APPLICATIONS

- **Current Stabilization,** by paralleling a conventional resistance in series with a power supply bus, to compensate for slowly varying supply voltage.
- **Thermostatic Control** of temperatures in household appliances, industrial processes.
- **Temperature Protection** against high or low temperature excursions in equipment or processes, by alarm and/or equipment shut-down.

TYPICAL ELECTRICAL CHARACTERISTICS

Resistance* At +25°C (±15Ω)	Resistance* At Other Temperatures		Switch** Temperature (°C)	Temperature Coefficient of R (%/°C)	V_{max} (VDC)	Dissipation Factor (mW/°C)	Thermal Time Constant (s)	Color Band	Part Number 2322-
	Temperature (°C)	Resistance (Ω)							
50Ω	100	>1000	+80	18	50	8.5	50	Yellow	661-91002
40Ω	130	> 10000	+110	75	50	8.5	50	Green	661-91003
30Ω	100	90 to 10000	+45	16	50	8.5	50	Orange	661-91004
50Ω	100	> 3000	+25	9	40	6	40	Red	661-91005

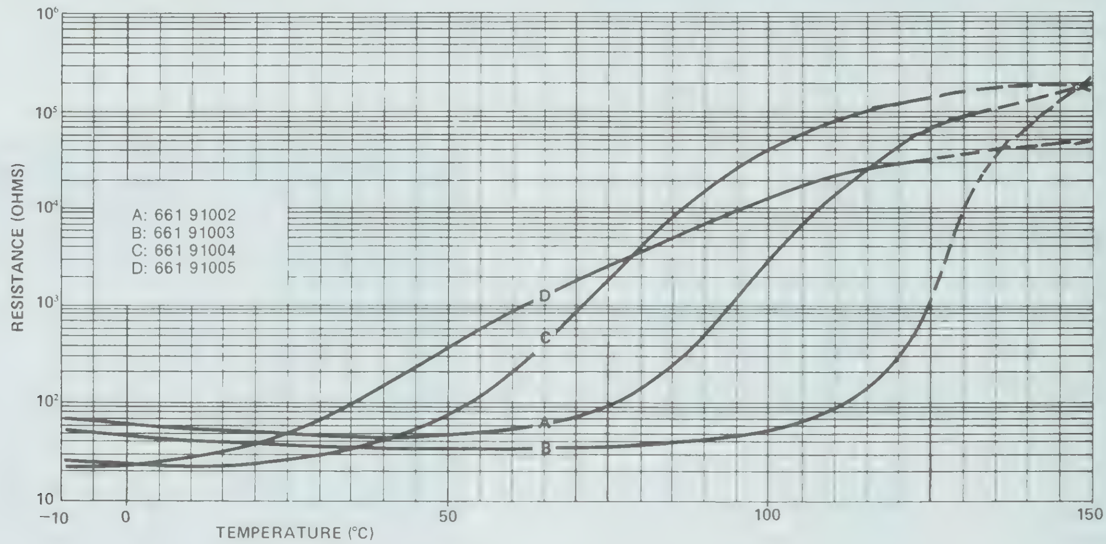
*Measuring voltage <1.5 V to avoid self-heating. Operating temperature range: −10° to +125°C at zero power; 0° to 55°C at V_{max}.
**Temperature at which the resistance is twice the normal resistance.

8 Non-Linear Resistors

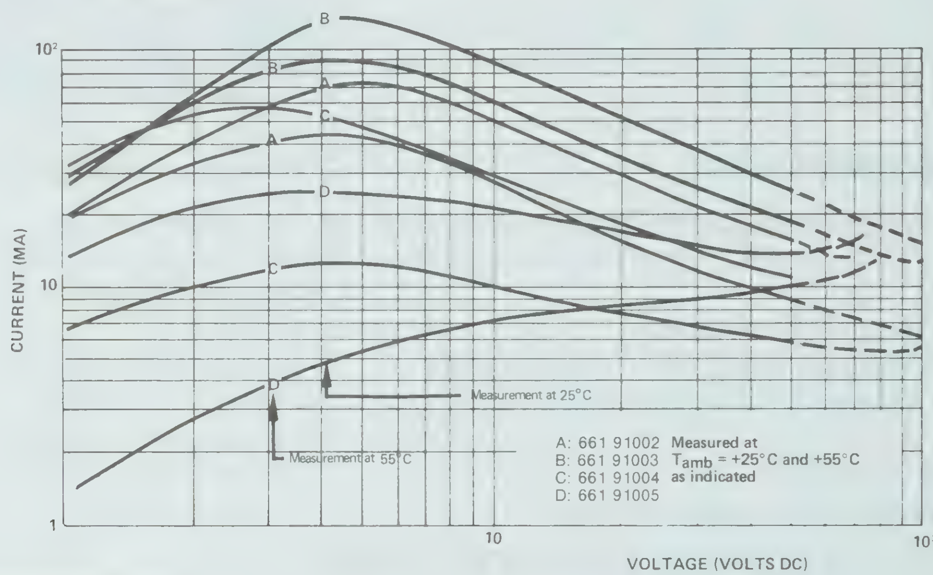
SERIES 661

Disc PTC Thermistors

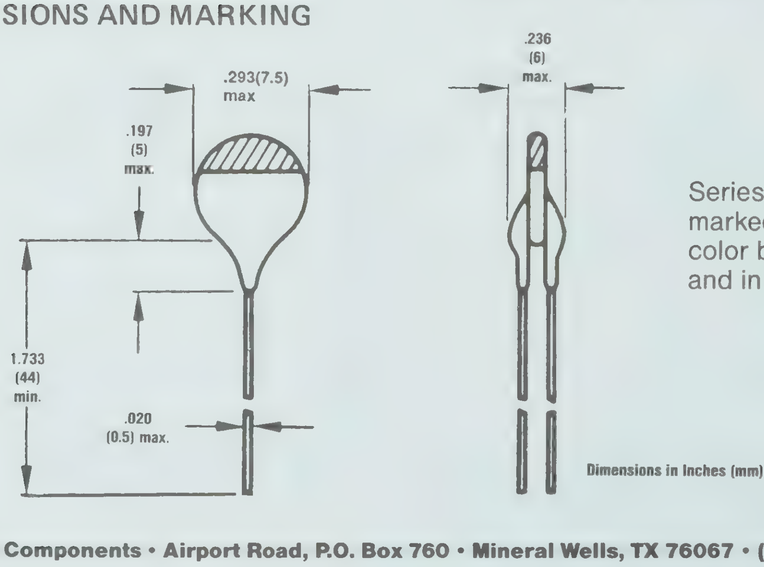
RESISTANCE vs TEMPERATURE



VOLTAGE vs CURRENT



DIMENSIONS AND MARKING



Series 661 thermistors are marked with an identifying color band, as indicated at left and in table on previous page.

8

Non-Linear Resistors

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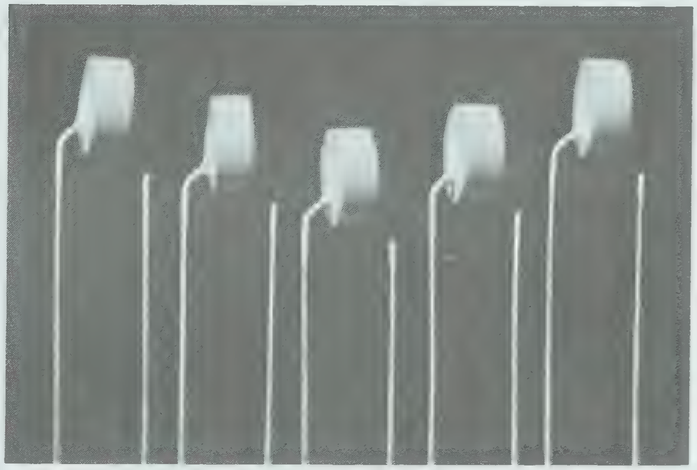
SERIES 662

Disc PTC Thermistors

23% to 35%/°C T.C. of R 36 to 120Ω at 25°C
75° to 115°C Switch Temperature

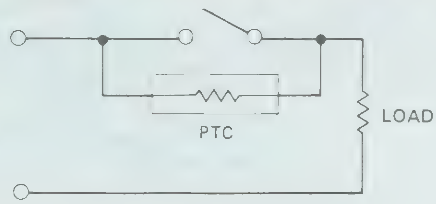
DESCRIPTION

Series 662 Thermistors are special designs featuring low cold resistances, high operating voltage ratings, particularly for pulse applications, and high switch temperatures. Their large positive temperature coefficients and long time constants are of significant value in protective circuitry, and time delay functions.



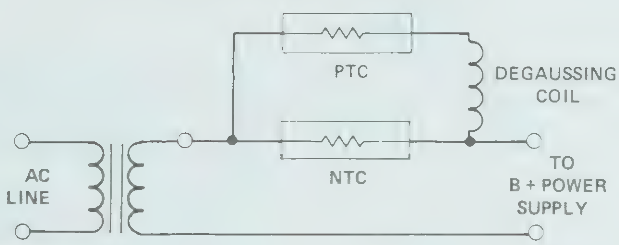
TYPICAL APPLICATIONS

- **Spark Suppression.** Type 662-91022 finds wide application in protection of switch and relay contact, particularly in telegraph relays. As diagrammed at right, when the contacts open, the low resistance of the cold thermistor prevents sparking by minimizing the voltage appearing across the contacts.



- **TV Degaussing Circuits.** Types 662-93036 and 93066 may be connected in series with the degaussing coil, with both shunted by an NTC thermistor, as shown in the adjacent diagram. Initially the NTC has a high resistance, the PTC a low resistance; this provides a high initial degaussing current.

  Because of their large physical size, the 662 Series can be used to achieve longer time delays, or as self-regulating heaters for components and ovens. As a heater, they can also activate bi-metallic controls.



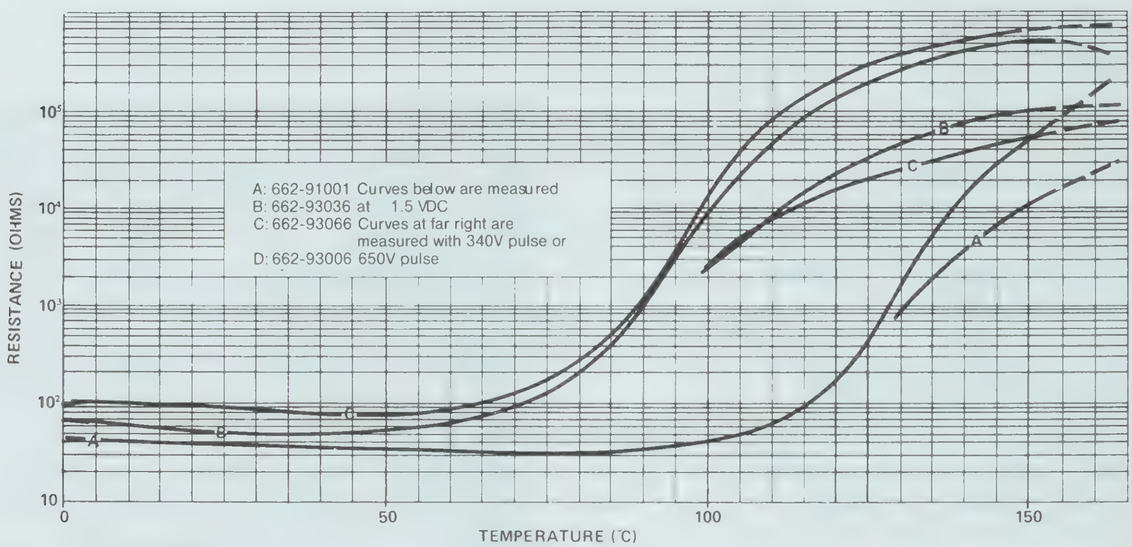
TYPICAL ELECTRICAL CHARACTERISTICS

Resistance* At +25°C (Ω)	Resistance* At Other Temperatures		Switch** Temperature (°C)	Temperature Coefficient of Resistance (%/°C)	Dissipation Factor (mW/°C)	Thermal Time Constant (sec)	Maximum Voltage (at 55°C)	Part Number (2322)
	Temperature (°C)	Resistance (Ω)						
36 to 50	+115° +165°† (180V pulse)	<120 >20K	+115°C	+35%	13	80	180 VDC	662-91001
45 to 60	+75°C +150°† (340V pulse)	<160 >45K	+75°	+20%	20	110	265 VRMS (33Ω Series Resistor)	662-93036
80 to 120	+72° +85° +150°† (380V pulse)	<2 x R_{25} >2 x R_{25} ≥40K	+75°	35%	15.3	80	265 VRMS (33Ω Series Resistor)	662-93066
70 to 100	100°	≤200	+120	+35%	11.5	115	460 VRMS (300 Ω Series Resistor)	662-93006

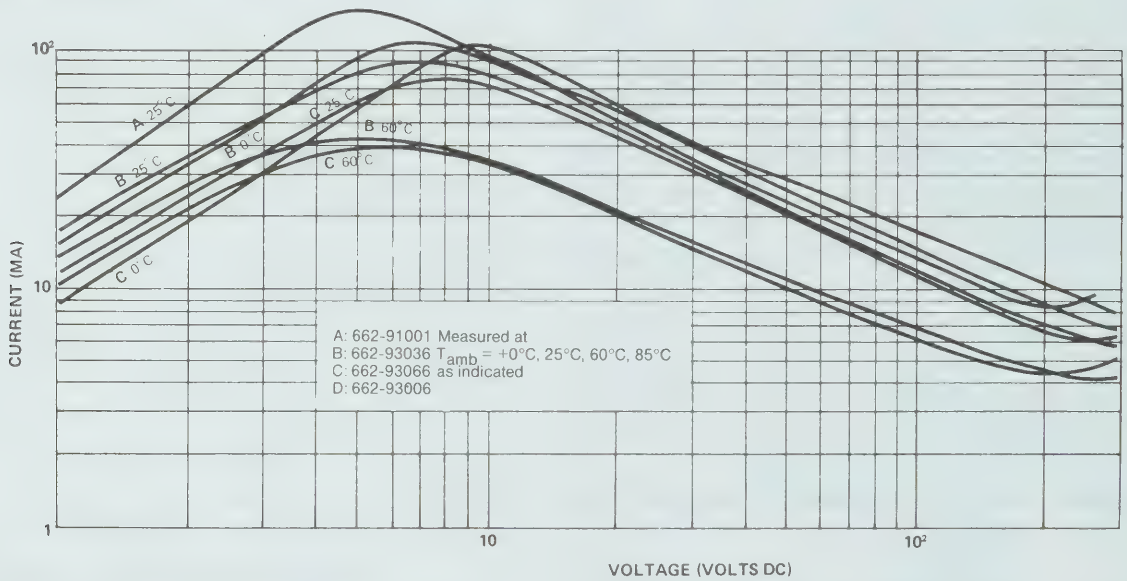
*Measuring voltage: 1.5 V to avoid self heating. Operating temperature at zero power, 0° to +155°C; 60°C maximum at maximum voltage.
†Pulse measurement without self-heating.
**Temperature at which the resistance is twice the minimum resistance.

SERIES 662
Disc PTC Thermistors

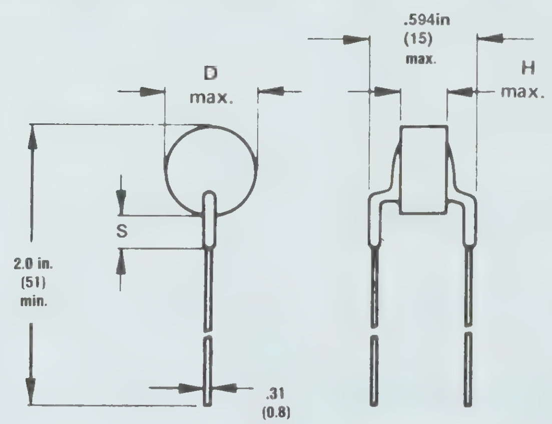
RESISTANCE vs TEMPERATURE



VOLTAGE vs CURRENT



DIMENSIONS AND MARKING



Dimensions in Inches (mm)

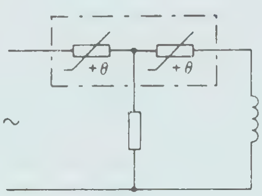
Part Number (2322)	Color	DIMENSIONS (max.)					
		D		H		S	
662-91022	Blue	.426	(10.8)	.190	(4.8)	.200	(5.0)
662-93006	none (disc only)	.473	(12)	.26	(5.6)	NA	NA
662-93036	Blue, green band	.50	(12.6)	.26	(6.5)	.315	(8.0)
662-93066	Red band	.42	(10.5)	.22	(5.5)	NA	NA
Thermistor body is lacquer coated (Except 662-93066 & 662-93006)							

Philips Components • Airport Road, P.O. Box 760 • Mineral Wells, TX 76067 • (817) 325-7871 • FAX: (817) 325-1052

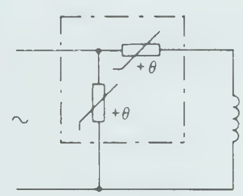
DESCRIPTION

The Series 662 PTC for degaussing was designed to provide economical & reliable color monitor degaussing.

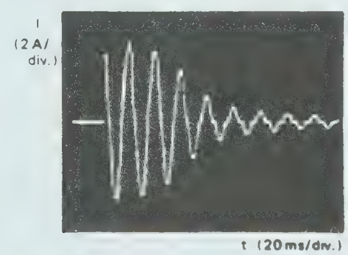
The colour purity of a television picture can be affected by residual magnetism in the tube's internal shielding, shadow mask, etc. This is caused by extraneous magnetic fields from domestic appliances, local high-powered electrical equipment or the earth's magnetic field. The tube is "degaussed" each time it is switched on by applying a strong alternating magnetic field, using coils surrounding the tube, which gradually and symmetrically decays to zero. Hence, the current for the degaussing coils must be large initially but decay to a small steady-state value. This current is produced by a PTC thermistor circuit which may use two thermistors in intimate thermal contact, one thermistor being used to heat the other and further reduce the residual current. The circuit can be made smaller by replacing the PTC/parallel resistor combination with a dual-PTC of the type shown in Fig. 1 (b). Besides reducing the number of components, this also improves reliability. Dual PTC's result in lower residual current than mono PTC units.



(a) Conventional circuit



(b) Modern structure



SERIES 662-96
Dual PTC For Degaussing

Part Number	Resistance At 25°C (Ohms)	Peak Inrush Current (Amps)	Maximum RMS Volts	Rated Coil Resistance	Residual Current at 180 Sec	Dimension Inches (mm) Figure 2
2322-662-96009	43	5.0	265	25.0	2.0 mA	.724 (18.4)
2322-662-96011	35	6.5	265	17.0	2.0 mA	.724 (18.4)
2322-662-96012	43	5.8	265	18.9	<10.0 mA	.724 (18.4)
2322-662-96013	8	10.0	145	6.2	5.0 mA	.724 (18.4)
2322-662-96016	28	6.0	265	25.0	3.0 mA	.724 (18.4)
2322-662-96022	43	5.0	265	25.0	0.5 mA	.724 (18.4)
2322-662-96024	43	5.0	265	25.0	2.0 mA	.724 (18.4)
2322-662-96111	35	6.5	265	17.0	2.0 mA	.807 (20.5)
2322-662-96116	24	6.0	265	25.0	3.0 mA	.807 (20.5)
2322-662-96118	40	5.0	265	25.0	1.0 mA	.807 (20.5)
2322-662-96121	35	6.5	265	17.0	1.4 mA	.807 (20.5)
2322-662-96123	18	8.1	245	14.0	3.0 mA	.807 (20.5)
2322-662-96124	20	20.0	270	10.0	15.0 mA	.807 (20.5)
2322-662-96125	8	16.0	140	9.0	7.0 mA	.807 (20.5)
2322-663-96101	5	20.0	144	11.0	< 3.0 mA	.807 (20.5)

All dimensions in inches (mm)

SERIES 66.

PTC Thermistors for Current Overload Protection

DESCRIPTION

Fast, reliable overload-protection is the hallmark of these thermistors. Selecting the right thermistor is simplicity itself. No more complex tables of data, curves and tedious calculations of resistances and voltages—these thermistors are selected on the basis of current alone, like fuses. Furthermore, they don't have to be renewed when normal load conditions resume, but can be easily reset like a circuit breaker. They provide the same high level of protection every time it's needed even down to a 40% current-overload (at 25°C).

Selection is simple because we specify guaranteed current switching levels. These range from a few mA to more than 1 A in a continuous range. All levels are well defined and stable over thermistor life, and ensure you choose the right thermistor every time. Once you've decided on the voltage rating (265 V or 56 V), you select on the basis of maximum overload current, nothing more. And that's all you need to know to start designing with this new range.

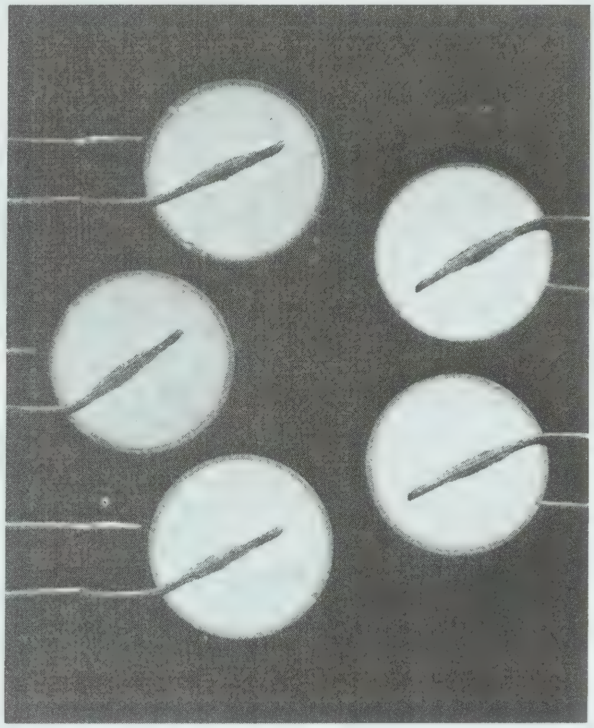


Table 1

V_{max} at +55°C = 265V; Ts = + 120°C

part number[1]	I_{nt} at 55°C (mA)	I_{nt}[2] at 25°C (mA)	I_t at 10°C (mA)	I_t[2] at 25°C (mA)	I_{max} (mA)	I_{res} (mA)	R_{25} Ω	D mW/°C	H mJ/°C	τ (s)	Dimensions, see figure 1 inches (mm) dia d	b_{max}	t_{max}	R/T Curve	V/I Curve
2322 660 11293	12	15.5	24	21.9	110	5	1900	6	120	20	.177 (4.5)	.197 (5)	.150 (3.8)	Fig. 2	Fig. 22
2322 660 11593	15	19.4	30	27.4	135	5	1200	6	120	20	.177 (4.5)	.197 (5)	.150 (3.8)	Fig. 3	Fig. 23
2322 660 11893	18	23.4	36	32.9	165	5	850	6	120	20	.177 (4.5)	.197 (5)	.150 (3.8)	Fig. 4	Fig. 24
2322 660 12293	22	28.4	44	40.2	200	6	560	6	120	20	.177 (4.5)	.197 (5)	.150 (3.8)	Fig. 5	Fig. 25
2322 660 12793	27	34.9	54	49.3	250	6	380	6	120	20	.177 (4.5)	.197 (5)	.150 (3.8)	Fig. 6	Fig. 26
2322 661 13393	33	42.6	66	60.2	290	7	280	7	220	31	.256 (6.5)	.197 (5)	.150 (3.8)	Fig. 7	Fig. 27
2322 661 13993	39	50.3	78	71.2	350	7	200	7	220	31	.256 (6.5)	.197 (5)	.150 (3.8)	Fig. 8	Fig. 28
2322 661 14793	47	60.7	94	85.8	420	7	140	7	220	31	.256 (6.5)	.197 (5)	.150 (3.8)	Fig. 9	Fig 29
2322 661 15693	56	72.3	112	102.2	500	8	100	7	220	31	.256 (6.5)	.197 (5)	.150 (3.8)	Fig. 10	Fig. 30
2322 661 16893	68	87.8	136	124.2	600	8	72	8	330	41	.315 (8)	.197 (5)	.150 (3.8)	Fig. 11	Fig. 31
2322 661 18293	82	105.9	164	149.7	730	9	50	8	330	41	.315 (8)	.197 (5)	.150 (3.8)	Fig. 12	Fig. 32
2322 661 11013	100	129.1	200	182.6	900	9	33	8	330	41	.315 (8)	.197 (5)	.150 (3.8)	Fig. 13	Fig. 33
2322 662 11213	120	154.9	240	219.1	1100	12	26	8.5	480	56	.394 (10)	.197 (5)	.150 (3.8)	Fig. 14	Fig. 34
2322 662 11513	150	193.6	300	273.7	1300	12	20	9.5	680	72	.472 (12)	.197 (5)	.150 (3.8)	Fig. 15	Fig. 35
2322 662 11813	180	232.4	360	328.6	1700	14	14	9.5	680	72	.472 (12)	.197 (5)	.150 (3.8)	Fig. 16	Fig. 36
2322 663 12213	220	284.0	440	401.7	2100	16	10	10	850	85	.512 (13)	.197 (5)	.150 (3.8)	Fig. 17	Fig. 37
2322 663 12713	270	348.6	540	493.0	2500	19	8	12	1300	108	.630 (16)	.197 (5)	.150 (3.8)	Fig. 18	Fig. 38
2322 664 13313	330	426.0	660	602.5	3000	25	7	16	2400	150	.787 (20)	.236 (6)	.189 (4.8)	Fig. 19	Fig. 39
2322 664 13913	390	503.5	780	712.0	3600	25	5	16	2400	150	.787 (20)	.236 (6)	.189 (4.8)	Fig. 20	Fig. 40
2322 664 14713	470	606.8	940	858.1	4300	25	3.5	16	2400	150	.787 (20)	.236 (6)	.189 (4.8)	Fig. 21	Fig. 41

V_{max} at +55°C = 56V; Ts = + 120°C

part number[1]	I_{nt} at 55°C (mA)	I_{nt}[2] at 25°C (mA)	I_t at 10°C (mA)	I_t[2] at 25°C (mA)	I_{max}[3] (mA)	I_{res} (mA)	R_{25} Ω	D mW/°C	H mJ/°C	t (s)	Dimensions, see figure 1 inches (mm) dia d	b_{max}	t_{max}	R/T Curve	V/I Curve
2322 660 15691	56	72.3	112	102.2	460	30	90	6	80	13	.177 (4.5)	.157 (4)	.110 (2.8)	Fig. 42	Fig. 56
2322 660 16891	68	87.8	136	124.2	600	30	60	6	80	13	.177 (4.5)	.157 (4)	.110 (2.8)	Fig. 43	Fig. 57
2322 660 18291	82	105.9	164	149.7	750	30	42	6	80	13	.177 (4.5)	.157 (4)	.110 (2.8)	Fig. 44	Fig. 58
2322 661 11011	100	129.1	200	182.6	950	35	32	7	150	21	.256 (6.5)	.157 (4)	.110 (2.8)	Fig. 45	Fig. 59
2322 661 11211	120	154.9	240	219.1	1300	35	22	7	150	21	.256 (6.5)	.157 (4)	.110 (2.8)	Fig. 46	Fig. 60
2322 661 11511	150	193.6	300	273.9	1600	40	18	7.5	160	21	.315 (8)	.157 (4)	.110 (2.8)	Fig. 47	Fig. 61
2322 662 11811	180	232.4	360	328.6	2200	45	12.5	8	420	53	.394 (10)	.177 (4.5)	.130 (3.3)	Fig. 48	Fig. 62
2322 662 12211	220	284.0	440	401.7	2900	50	9	9	550	61	.472 (12)	.177 (4.5)	.130 (3.3)	Fig. 49	Fig. 63
2322 662 12711	270	348.6	540	493.0	4000	50	6.5	9	550	61	.472 (12)	.177 (4.5)	.130 (3.3)	Fig. 50	Fig. 64
2322 663 13311	330	426.0	660	602.5	6300	60	4.3	10	830	83	.512 (13)	.197 (5)	.150 (3.8)	Fig. 51	Fig. 65
2322 663 13911	390	503.5	780	712.0	7300	70	3.8	12	1240	103	.630 (16)	.197 (5)	.150 (3.8)	Fig. 52	Fig. 66
2322 663 14711	470	606.8	940	808.0	12000	70	2.6	12	1240	103	.630 (16)	.197 (5)	.150 (3.8)	Fig. 53	Fig. 67
2322 664 15611	560	723.0	1120	1022.0	14000	100	2.2	16	2340	146	.787 (20)	.236 (6)	.189 (4.8)	Fig. 54	Fig. 68
2322 664 16811	680	878.0	1360	1242.0	18000	100	1.6	16	2340	146	.787 (20)	.236 (6)	.189 (4.8)	Fig. 55	Fig. 69

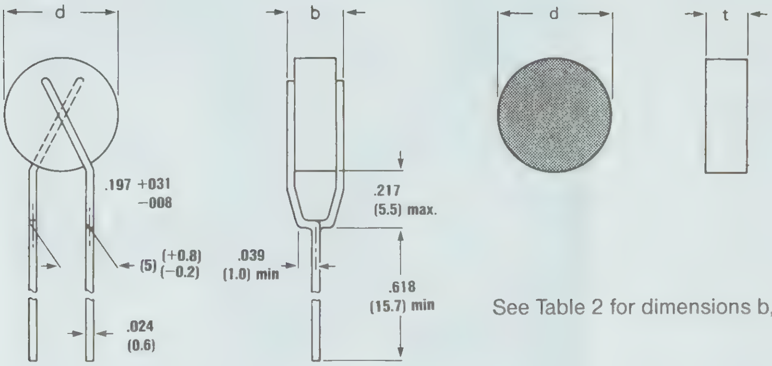
1) Replace the eighth digit (1) by a zero for the part number of a leadless thermistor.

2) I_t and I_{nt} are limits for the thermistors mounted according to IEC TC40. The values at 25°C are given as a practical indication of performance.

3) The high current rating of the low-voltage range means that these thermistors protect against short-circuit currents from any voltage source up to 18V.

SERIES 66.

Figure 1



See Table 2 for dimensions b, d and t.

Dimensions In Inches (mm)

Leaded thermistor. Types with a diameter less than 12 mm are available on radial mounting tape.
To order taped thermistors, replace the eighth digit of the part number (1) by a 3.

Leadless thermistor. The faces of each disc are metallized.

Terminology

V_{max} the maximum a.c. or d.c. voltage that may be applied to the thermistor under specified conditions

I_l load current

I_{ov} overload current

I_{max} the maximum permissible thermistor current at $T_{amb} = 0°C$.

I_{nt} not trip current: the guaranteed maximum r.m.s. current at which the operating point of the thermistor will be in the low-resistance region, specified at a high ambient temperature (+55°C).

I_t trip current: guaranteed minimum r.m.s. current causing the operating point of the thermistor move from the low-resistance region to the high-resistance region, specified at a low ambient temperature (+10°C).

I_{res} residual current at V_{max} and at $T_{amb} = +10°C$.

R_{25} typical thermistor resistance at 25°C.

T_S switching temperature: the higher of the two temperatures at which the thermistor resistance is twice the minimum resistance.

D dissipation factors: the amount of heat dissipated for each degree Celsius of difference between the temperature of the thermistor body and the surrounding atmosphere, measured in still air.

H thermal capacity of the thermistor.

τ thermal time constant of the thermistor, equal to H/D.

Soldering

Leaded thermistors

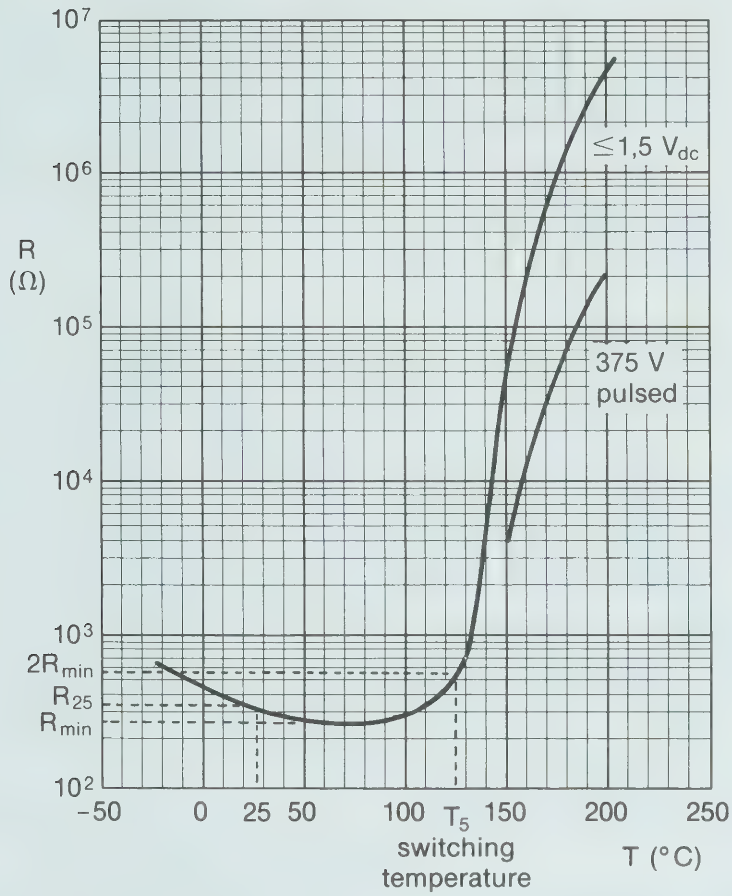
Leaded thermistors may be hand or machine soldered using a 50% Sn/Pb solder. Maximum solder temperature is 240°C for up to 4 s.

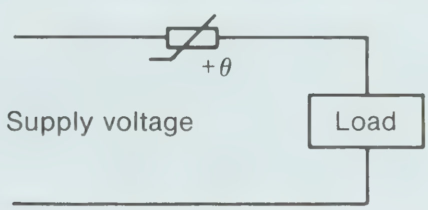
Leadless thermistors

The faces of leadless thermistors are metallized for solderability. Before soldering, it is recommended that the thermistors are heated to 100°C. While soldering, apply heat evenly to the whole of the disc face. Use a 50% Sn/Pb solder and a flux containing colofonium and ethyl alcohol. Maximum solder temperature is 270°C for up to 4 s.

Note: These thermistors are for applications where current overloads are due to fault conditions or equipment misuse. They are not suitable for applications requiring repetitive switching of the thermistor.

RESISTANCE/TEMPERATURE CHARACTERISTIC





(above) Typical resistance-temperature characteristic of a PTC thermistor. The strong positive temperature coefficient of resistance can be used for either current-sensitive switching or temperature-sensitive switching.

The thermistors in this brochure are current sensors—overload currents heat them, increasing their resistance. Always connect them in series with the load to be protected *(right)*. Contrast these thermistors with indirectly-heated thermistors, the latter don't carry load currents, but sense them by their heating effect.

SERIES 66.

DESIGNING WITH PTC OVERLOAD THERMISTORS

Thermistor requirements

The thermistor should:

- have no effect on circuit operation for currents up to the normal maximum load current, at all temperatures up to the maximum ambient temperature $T_{amb\ max}$.
- have high resistance at currents higher than the defined minimum overload current, at temperatures down to the minimum that will be experienced.

How to select the right thermistor

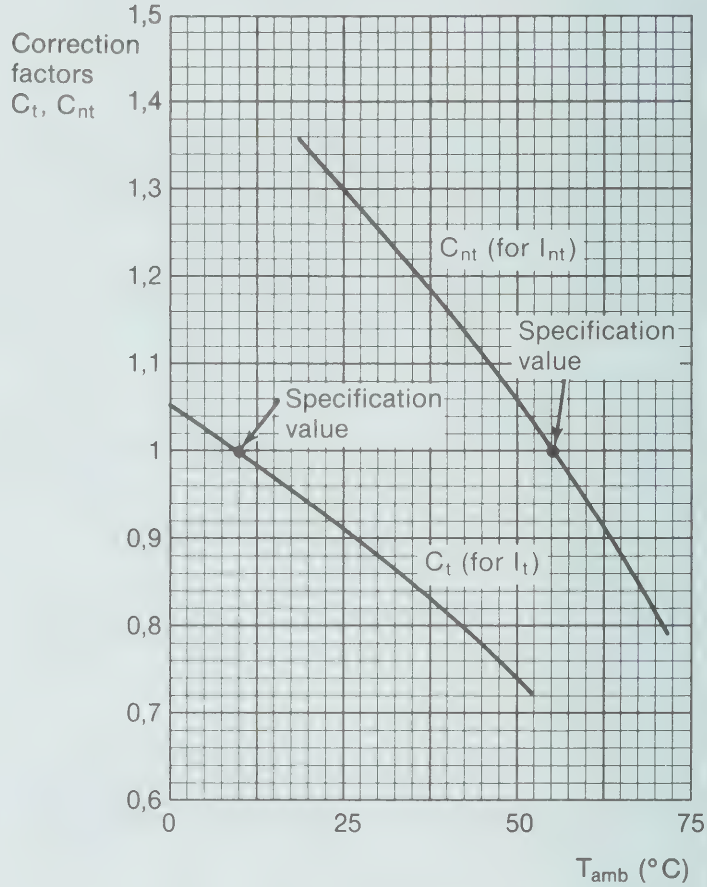
1. Define the maximum load current of the equipment at maximum ambient temperature ($I_{1\ max}$ at $T_{amb\ max}$).
2. Define the minimum overload current at minimum ambient temperature ($I_{ov\ min}$ at $T_{amb\ min}$).
3. Determine the minimum required I_{nt} at 55°C using the correction factor C_{nt}, read from the graph, for I_{nt} at $T_{amb\ max}$:
   minimum required I_{nt} at 55°C $= I_{1\ max}/C_{nt}$.
4. Choose the first thermistor, in the correct voltage range, having I_{nt} (at 55°C) higher than that calculated.
5. Determine I_t at minimum ambient temperature for the chosen thermistor using the correction factor C_t for I_t:
   I_t at $T_{amb\ min} = I_t$ at 10°C $\times C_t$.
   I_t at $T_{amb\ min}$ should always be lower than $I_{ov\ min}$ at $T_{amb\ min}$.
6. Test the thermistor in circuit. Mounting thermistors near hot components or in warm air streams can effect switching performance. For reproducible results, always mount the thermistor up to the kinks in their leads.

Design example

Protecting a triac-controlled motor from damage should the triac conduct on alternate half cycles only.

Motor: 220/240 V a.c., 40 VA.

1. Maximum load current $I_{1\ max}$ at maximum ambient temperature (35°C)
   360 mA (true r.m.s.)
2. Minimum overload current $I_{ov\ min}$ at minimum ambient temperature (15°C)
   800 mA (true r.m.s.)



Correction factors for I_t and I_{nt} for different ambient temperatures.

3. Correction factor for I_{nt} at 35°C
   So, the minimum required I_{nt} at 55°C is 360/1,2 = 300 mA
4. Select the first thermistor in the range having 0_{nt} at 55°C higher than that calculated—the 330 mA type (2322 664 13313).
5. Check that the maximum load current at maximum ambient temperature won't switch the thermistor, and that the minimum overload current at minimum ambient temperature will switch it:
   I_{nt} at 35°C $= I_{nt}$ at 55°C $\times C_{nt}$
   $= 330 \times 1{,}2 = 396$ mA. So the maximum load current (360 mA) won't switch the thermistor.
   I_t at 15°C $= I_t$ at 10°C $\times C_t$
   $= 660 \times 0{,}97 = 640$ mA. So the minimum overload current (800 mA) will switch the thermistor.

8 Non-Linear Resistors

SWITCHING TIME

When an overload current flows through a PTC thermistor, a short time elapses before the thermistor heats up to its high-resistance state and starts limiting the current. The switching time t_s is defined as the time for the thermistor body temperature to reach the switching temperature T_s after an overload has occurred.

t_s depends on:

- the overload current
- the normal load current
- the thermal capacity of the thermistor and the heat lost by the thermistor to the surroundings

Normalized switching times for various load and overload currents are shown in the graph on the right. The absolute value of t_s for a particular thermistor can be evaluated using the value of t given in the Range Tables. Switching time increases with increasing thermistor size (larger thermal capacity H) and decreases with increasing overload current.

When there is no preheating of a thermistor due to a normal load current (for example, when an overload occurs as an equipment is switched on), $I_1/I_t = 0$.

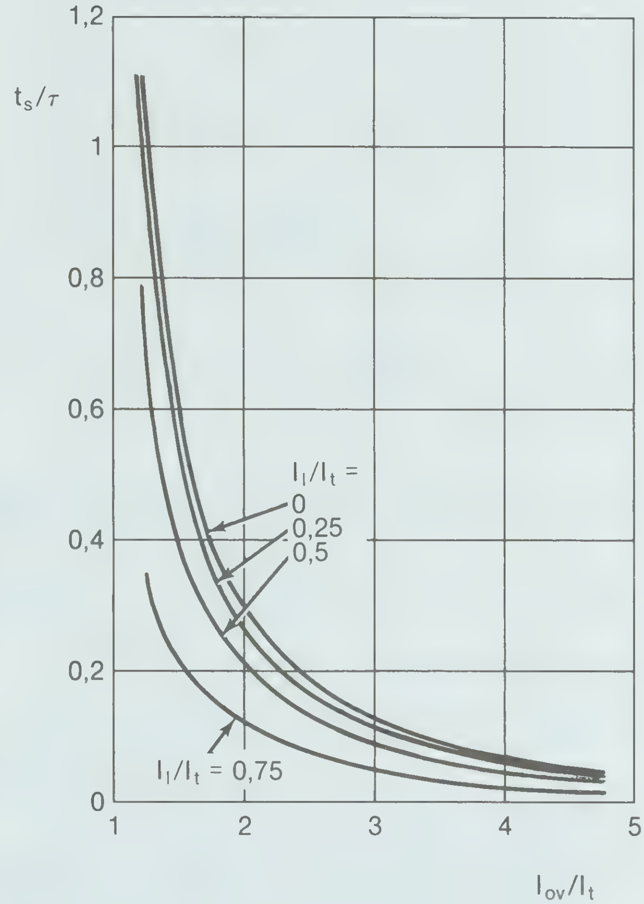
How to calculate switching time

For the 2322 664 13313 thermistor chosen in the design example:

t= 150 s,

and $I_{t\,typ}$ at 25°C = 522 mA.

Typical load current of the motor was 300 mA and typical overload current 850 mA.



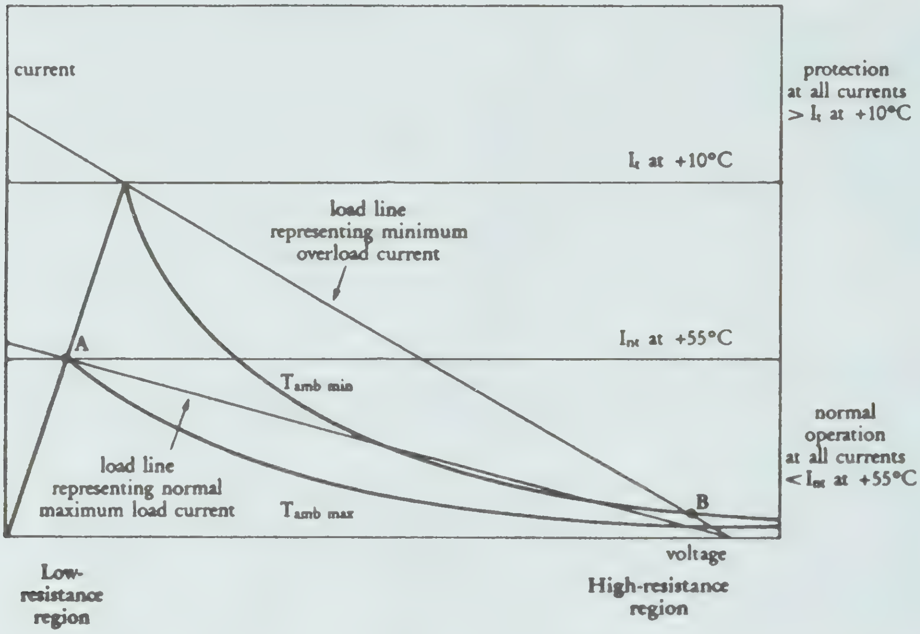
Normalized switching times of thermistors for various load and overload currents. All currents are typical. Overload is approximated by a step function change of load current as often occurs in practice.

8

Non-Linear Resistors

SERIES 66.

GUARANTEED CURRENT SWITCHING LEVELS



Guaranteed I_t and I_{nt} levels ensure:

- that the operating point stays within the low-resistance region of the voltage-current characteristic for all currents up to maximum load current (point A).
- that the operating point moves to the high-resistance region of the characteristic (point B) for all currents higher than the minimum overload current.

All thermistors in this brochure have $\frac{I_t\ (\text{at } 10°C)}{I_{nt}\ (\text{at } 55°C)} \leq 2$, guaranteed; protection no ordinary thermistors can match.

Typical resistance/temperature characteristics.

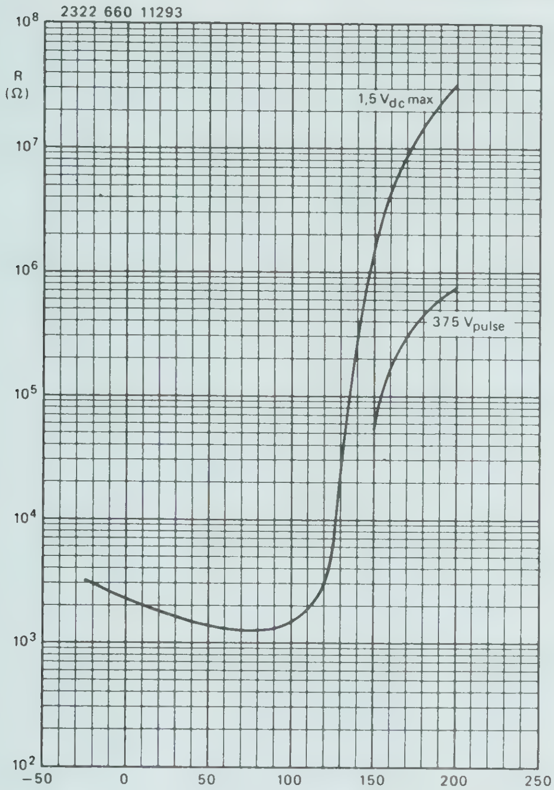


Fig. 2.

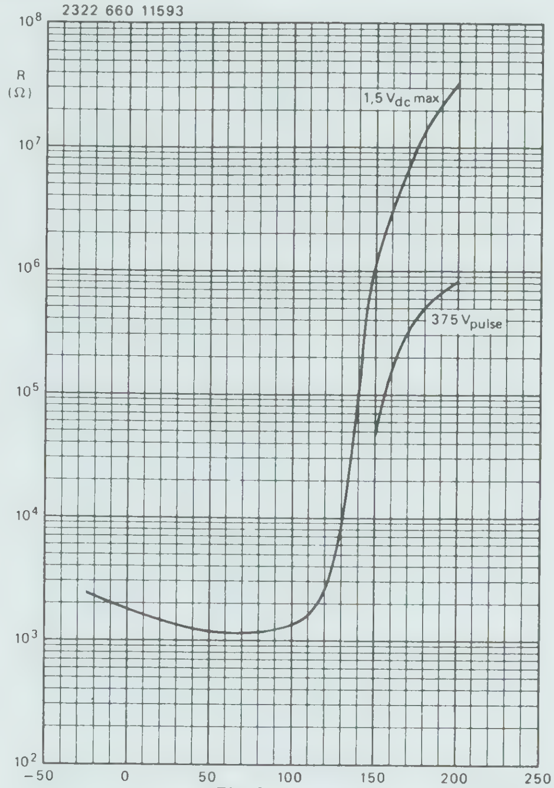


Fig. 3.

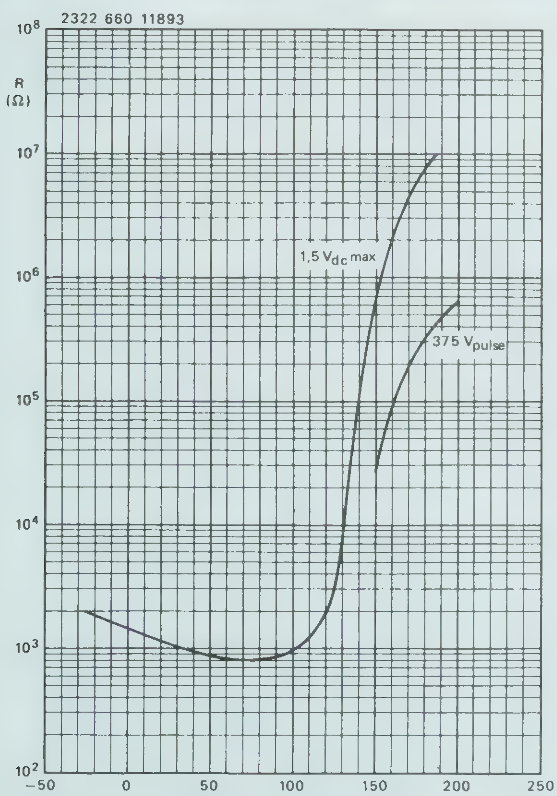


Fig. 4.

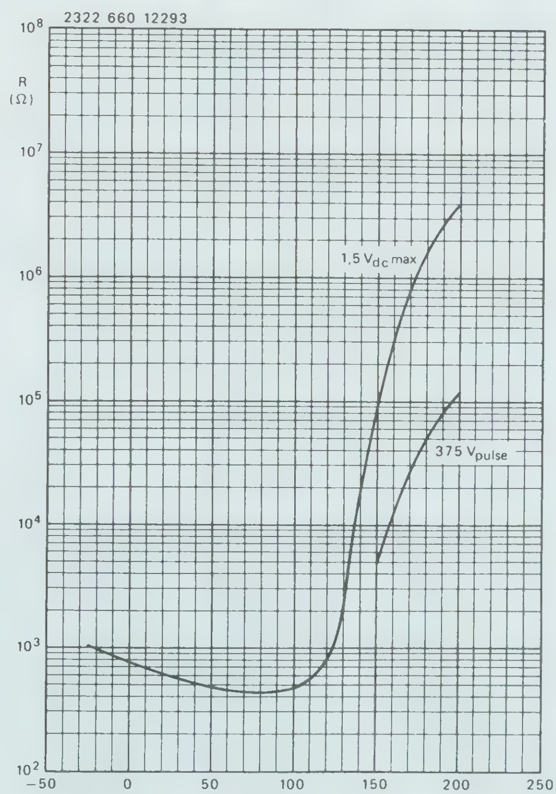


Fig. 5.

SERIES 66.

Current Overload Protection

Typical resistance/temperature characteristics.

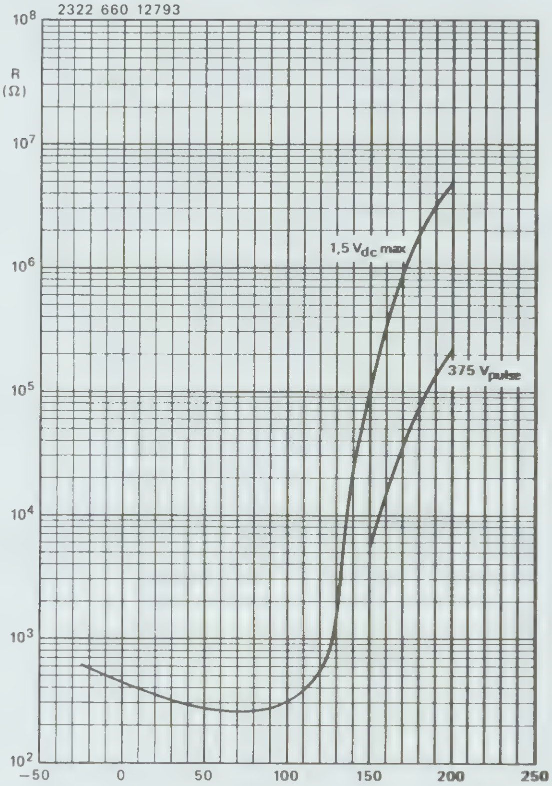
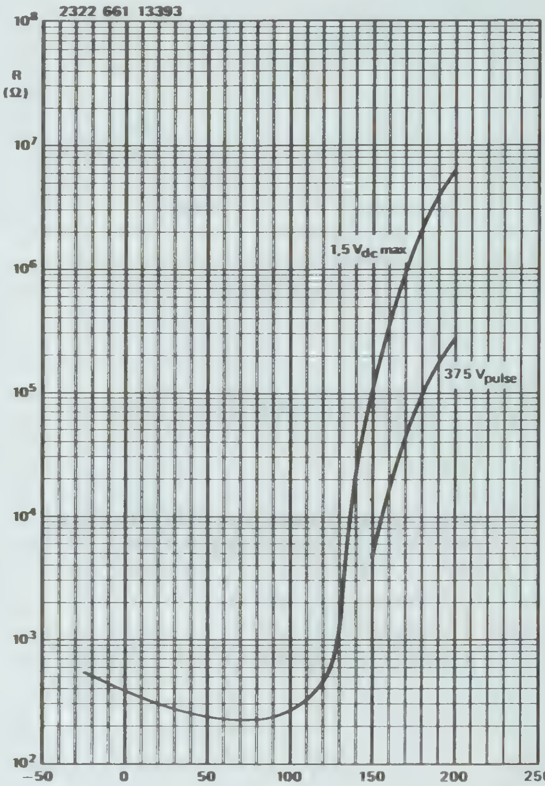


Fig. 6.



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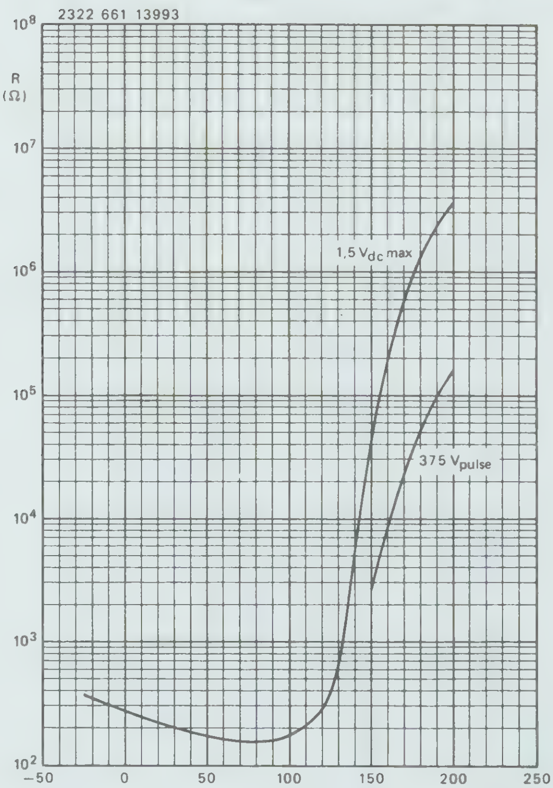


Fig. 8.

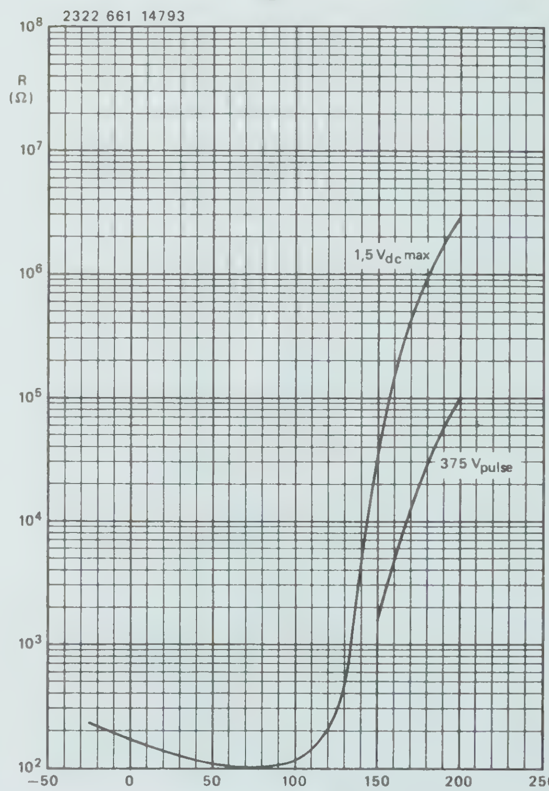
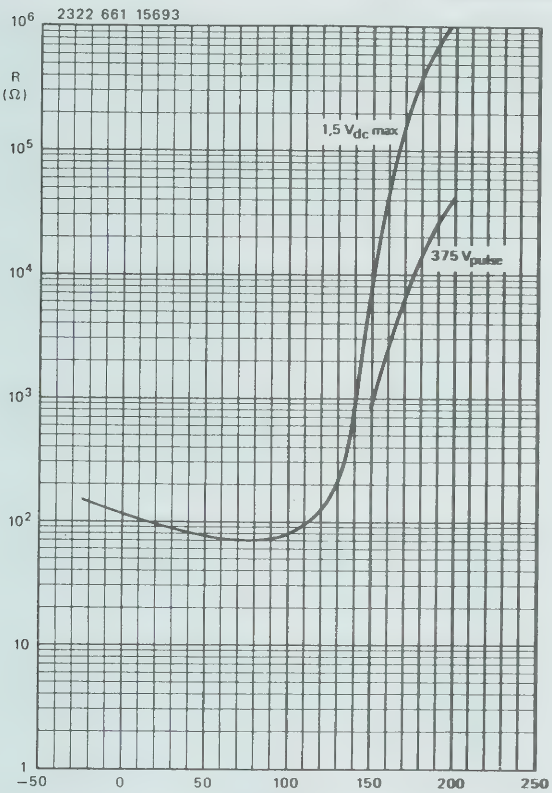


Fig. 9.

Typical resistance/temperature characteristics.



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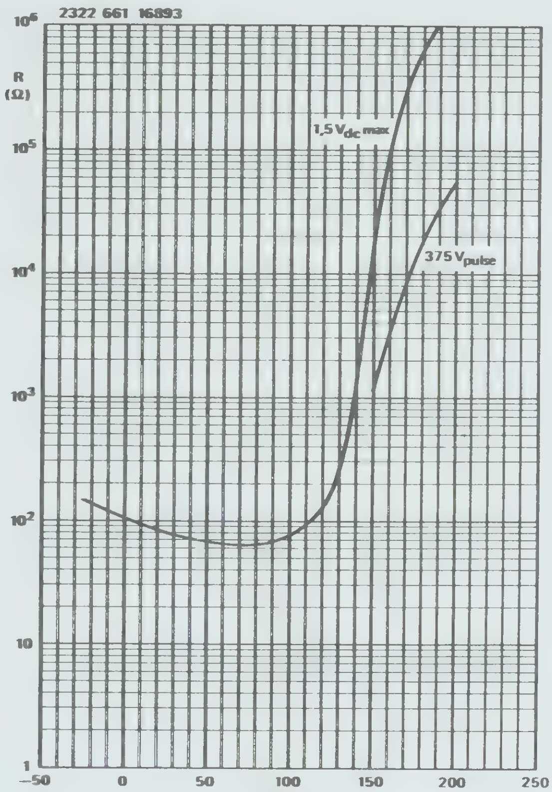

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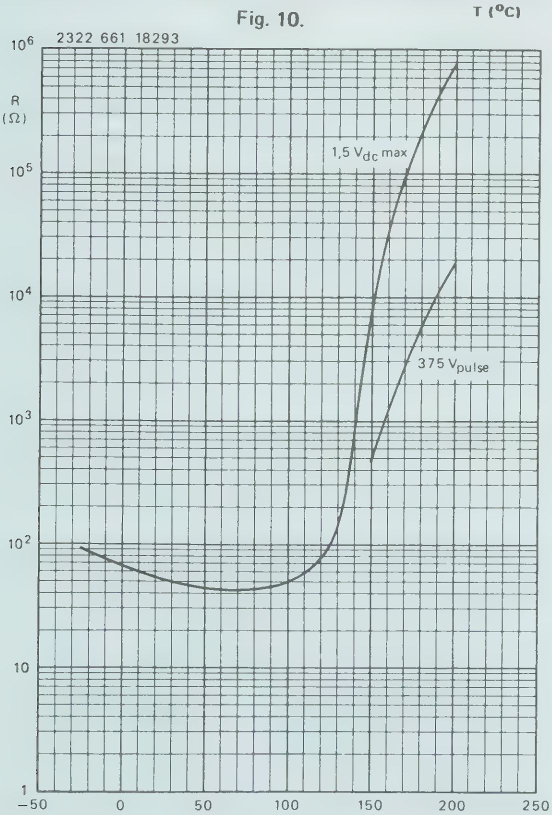

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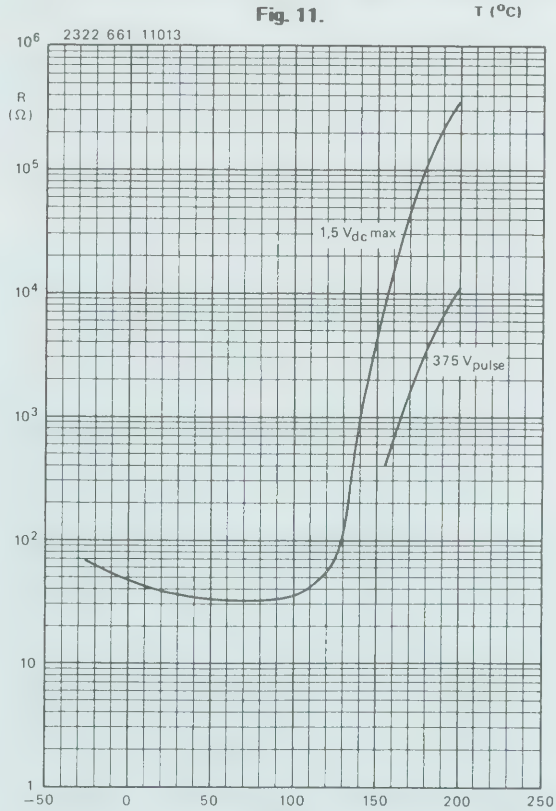

Fig. 13.

SERIES 66.

Current Overload Protection

Typical resistance/temperature characteristics.

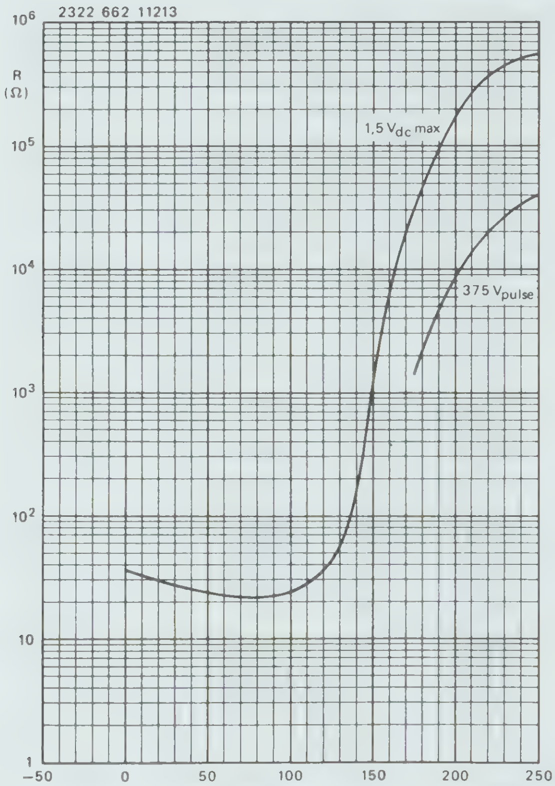

Fig. 14.

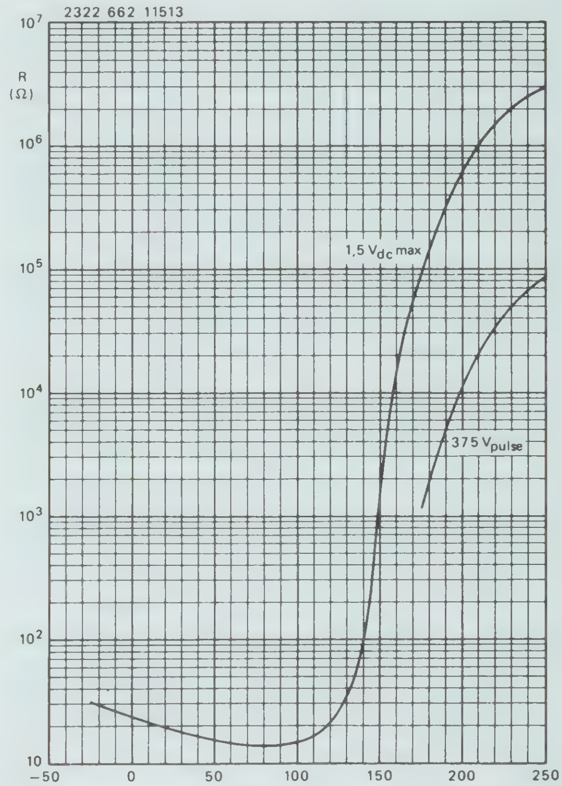

Fig. 15.

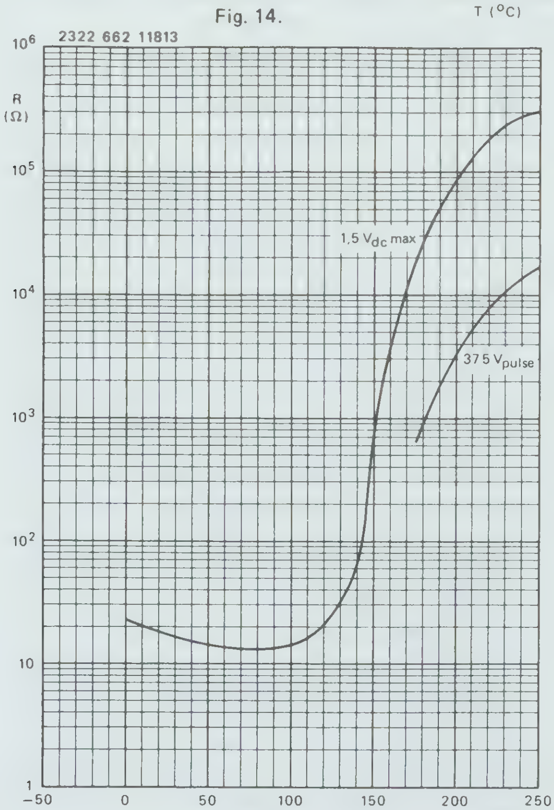

Fig. 16.

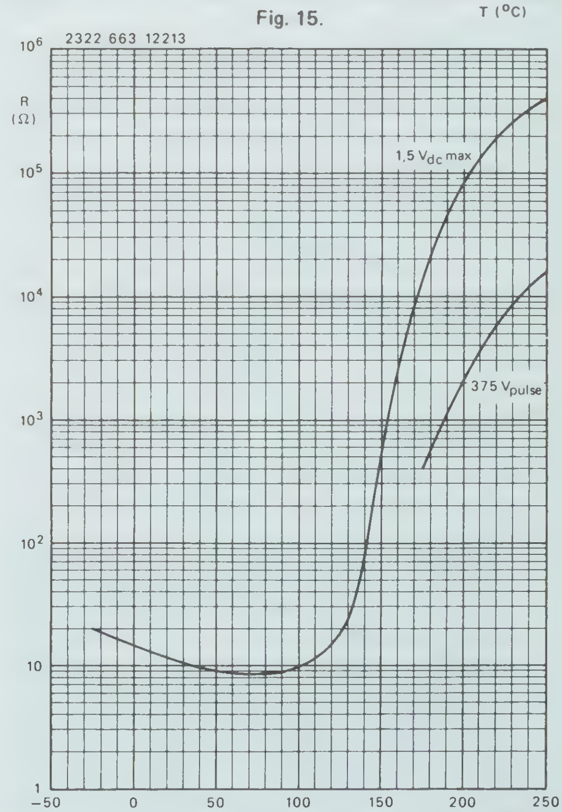

Fig. 17.

8 Non-Linear Resistors

Typical resistance/temperature characteristics.

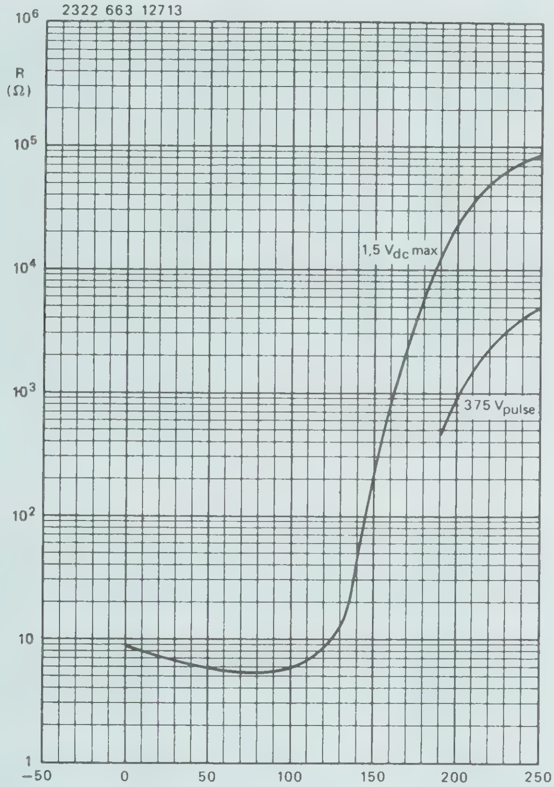

Fig. 18.

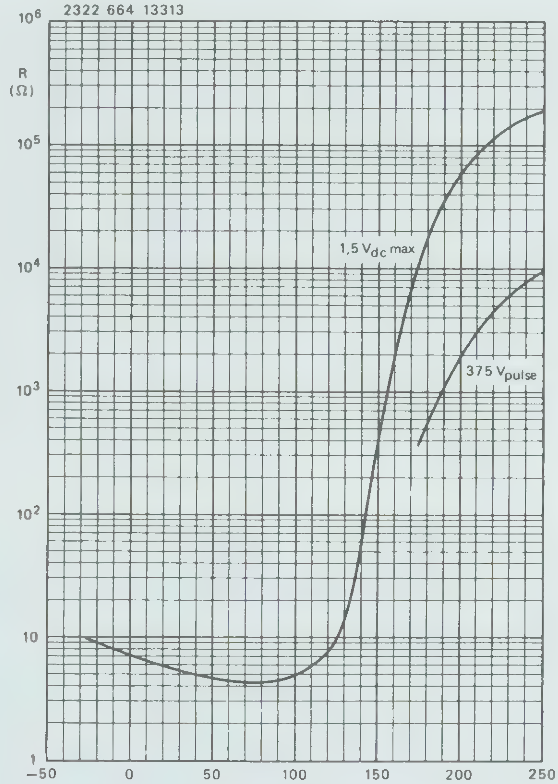

Fig. 19.

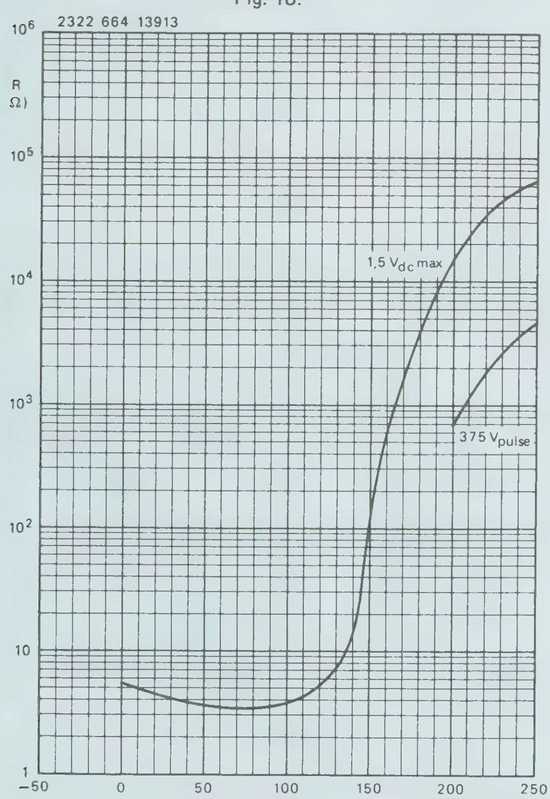

Fig. 20.

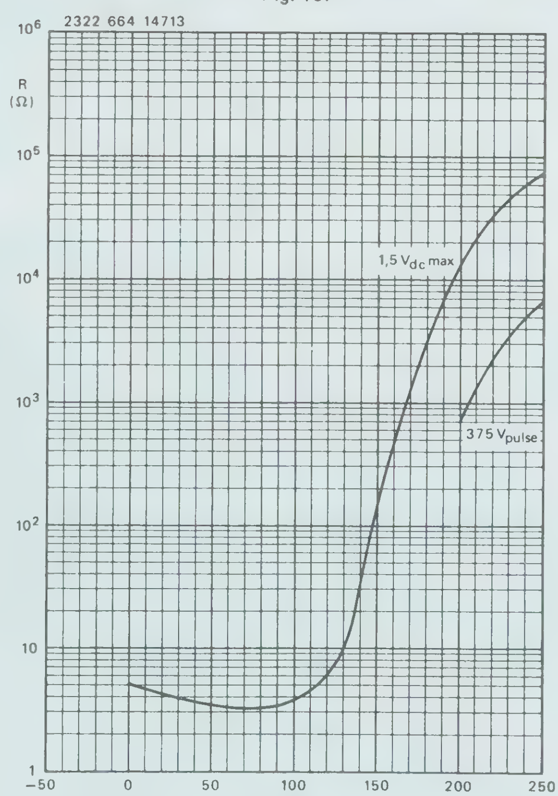

Fig. 21.

Current Overload Protection

Typical voltage/current characteristics.

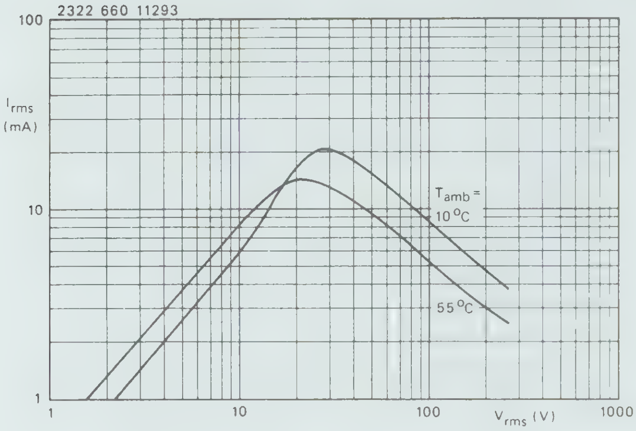

Fig. 22.

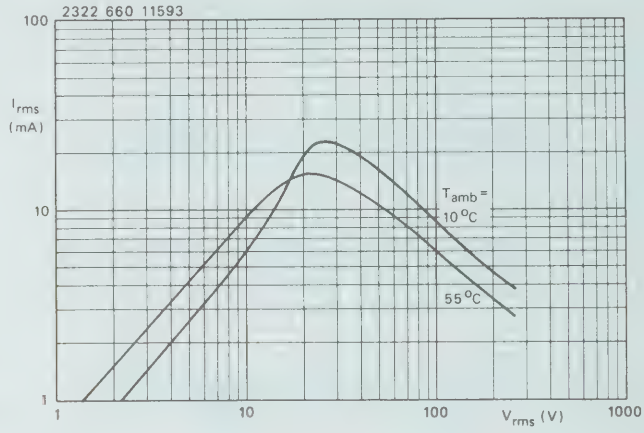

Fig. 23.

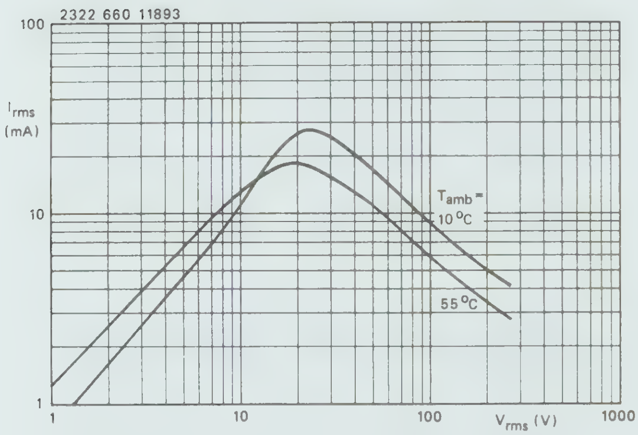

Fig. 24.

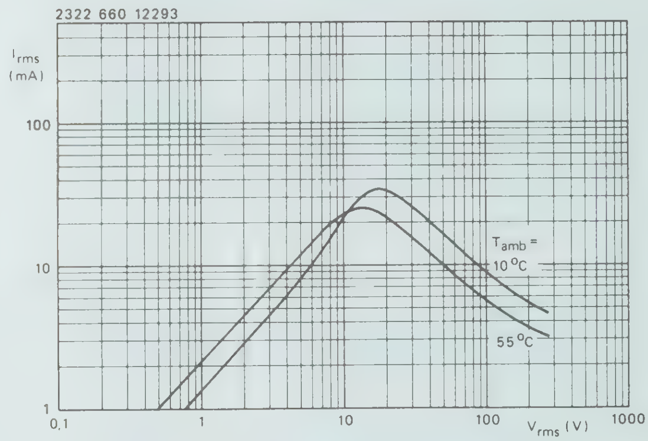

Fig. 25.

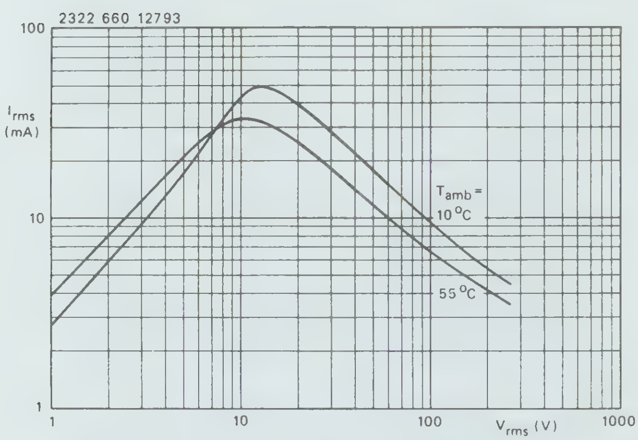

Fig. 26.

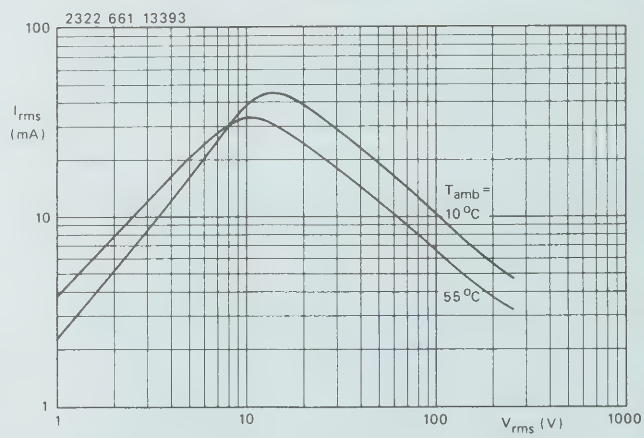

Fig. 27.

Typical voltage/current characteristics.

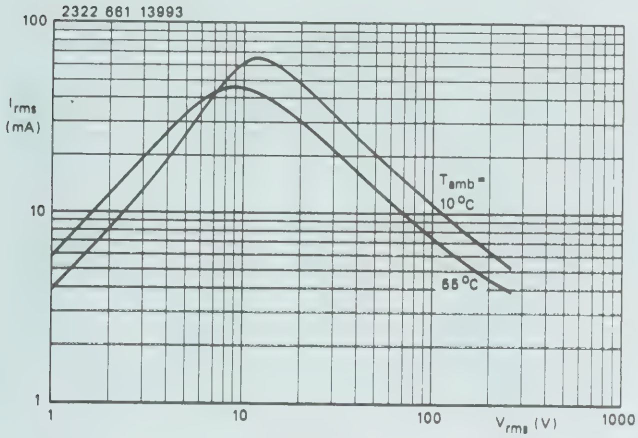

Fig. 28.

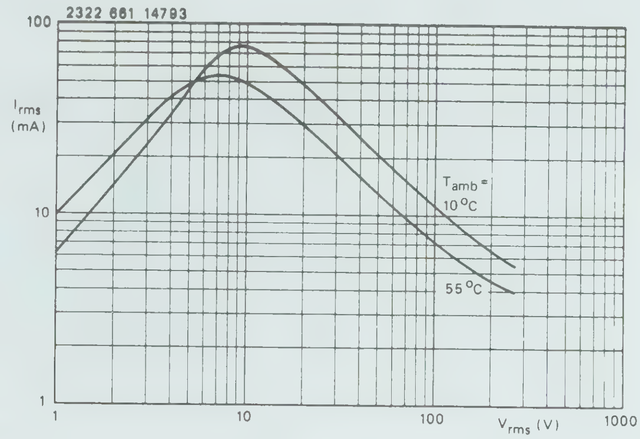

Fig. 29.

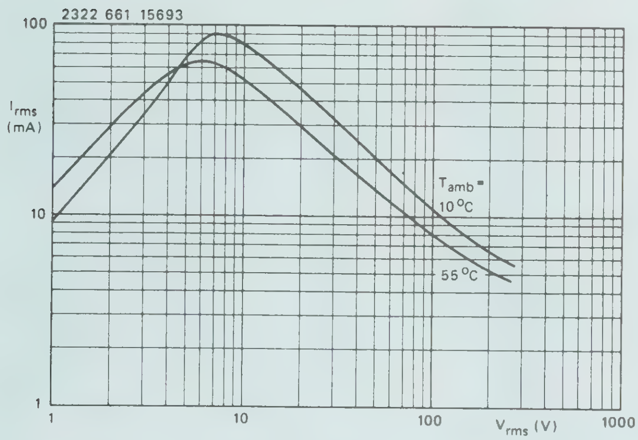

Fig. 30.

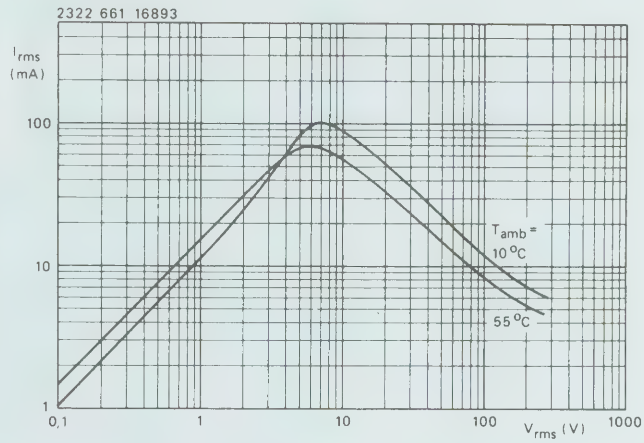

Fig. 31.

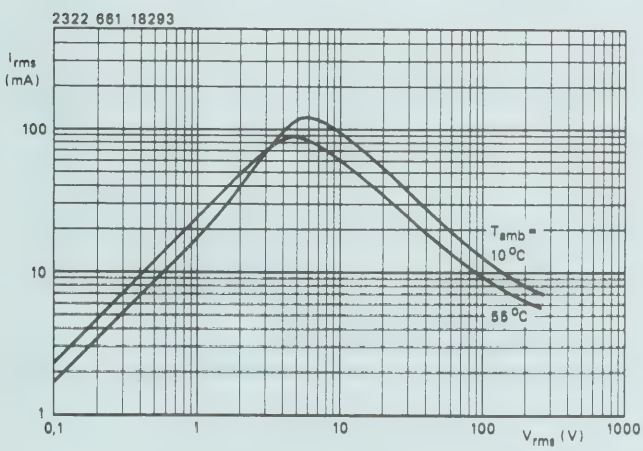

Fig. 32.

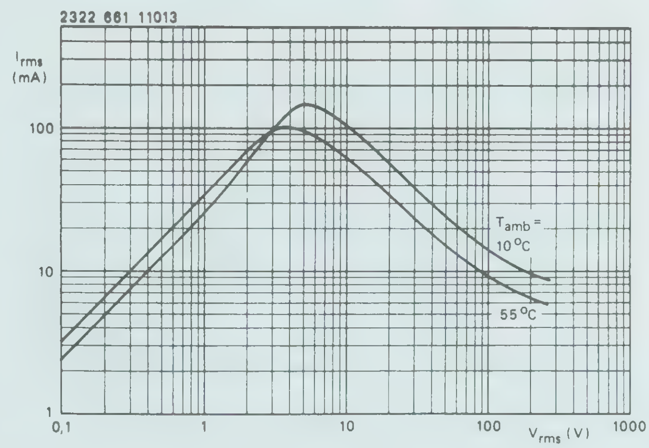

Fig. 33.

SERIES 66.
Current Overload Protection

Typical voltage/current characteristics.

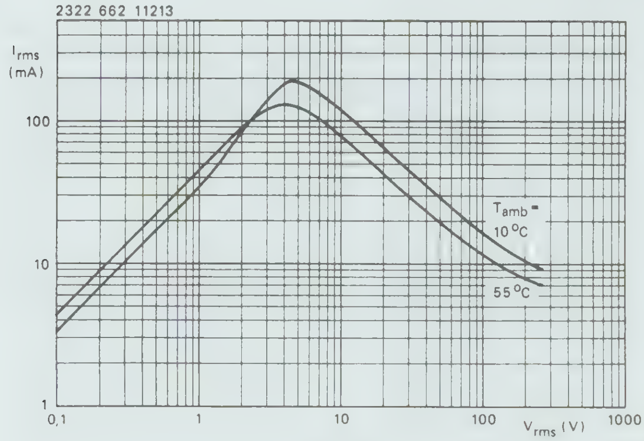

Fig. 34.

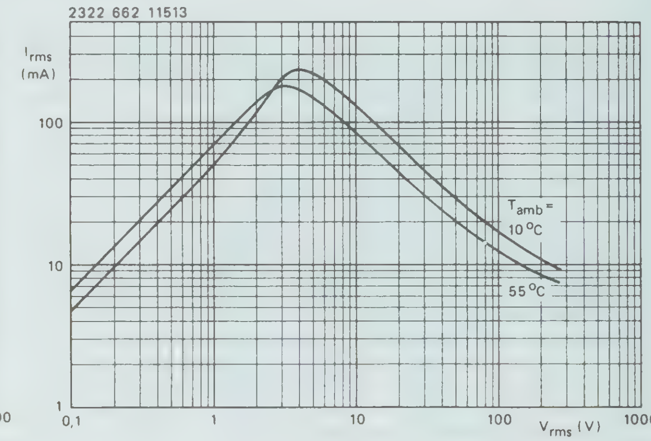

Fig. 35.

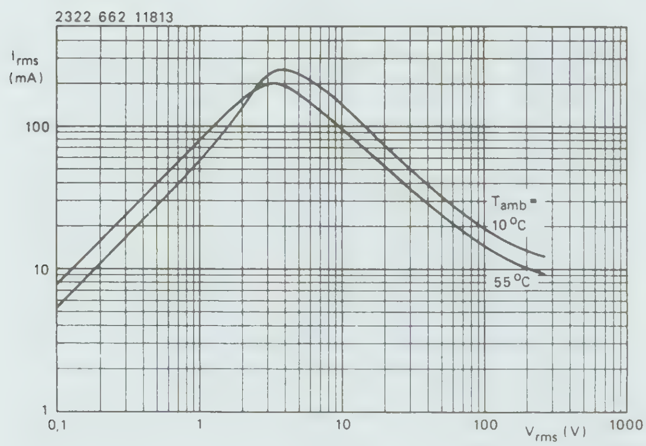

Fig. 36.

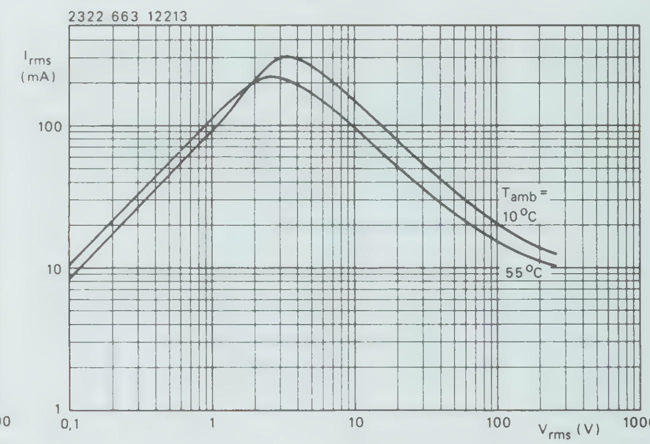

Fig. 37.

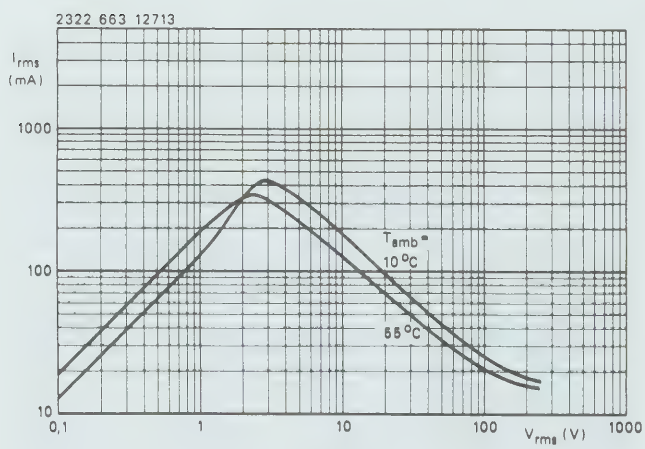

Fig. 38.

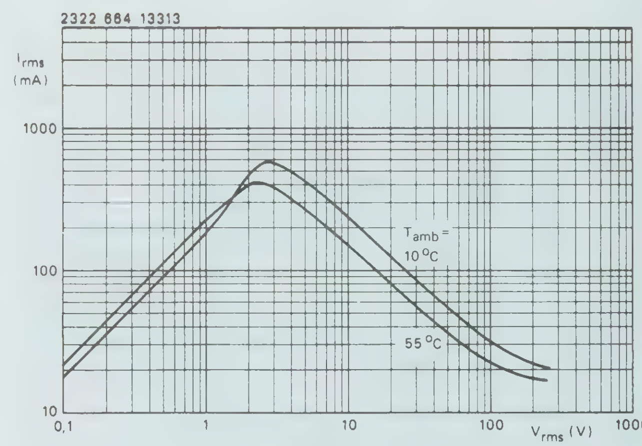

Fig. 39.

Typical voltage/current characteristics.

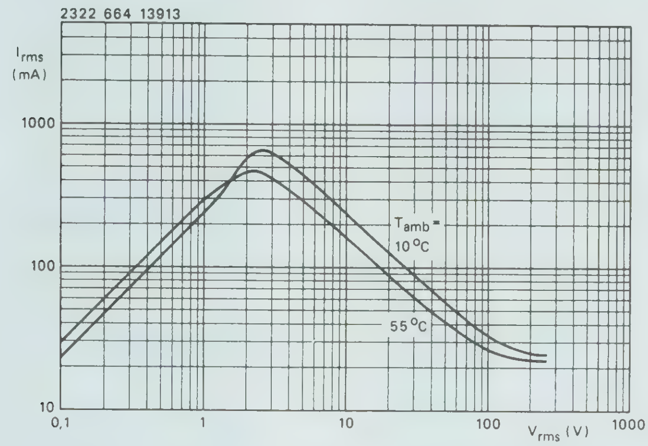

Fig. 40.

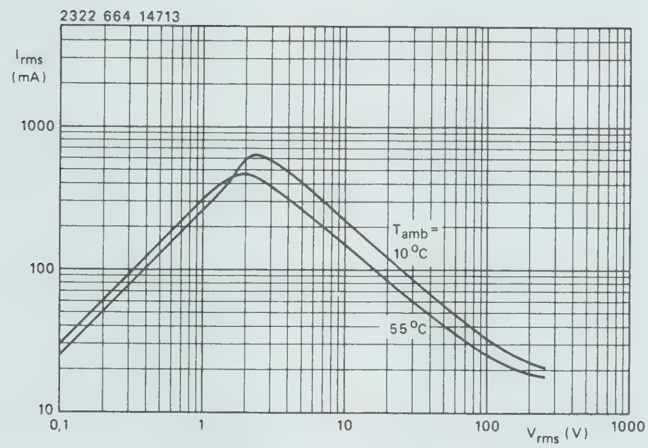

Fig. 41.

Typical resistance/temperature characteristics.

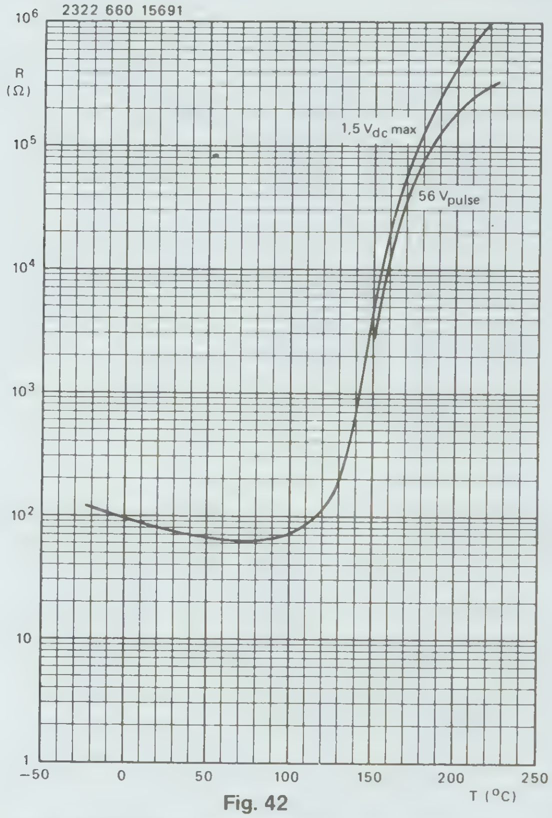

Fig. 42

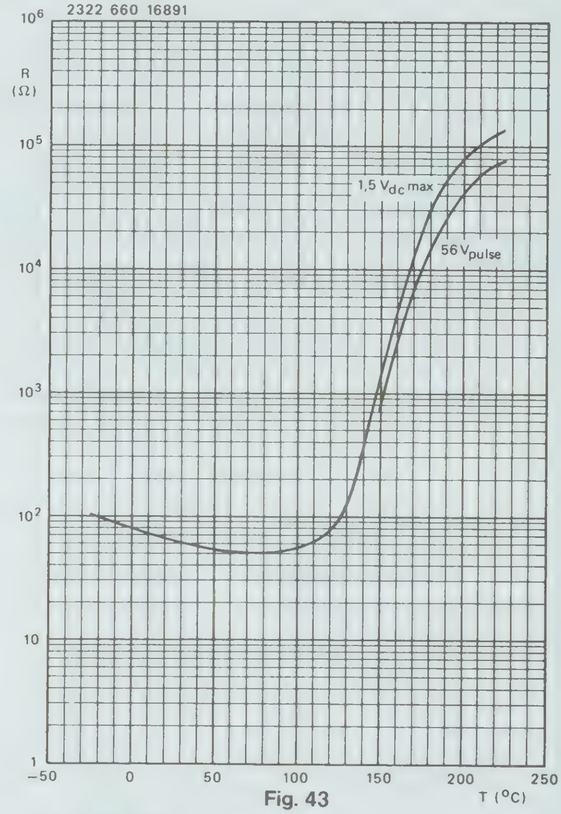

Fig. 43

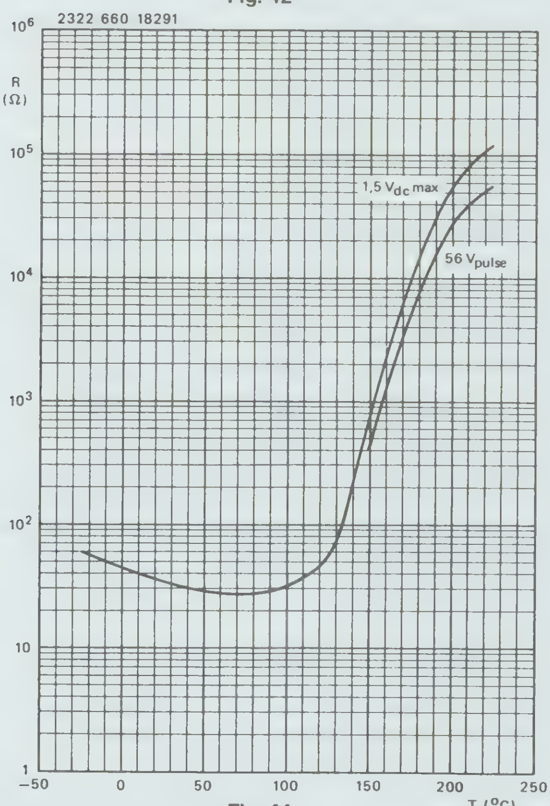

Fig. 44

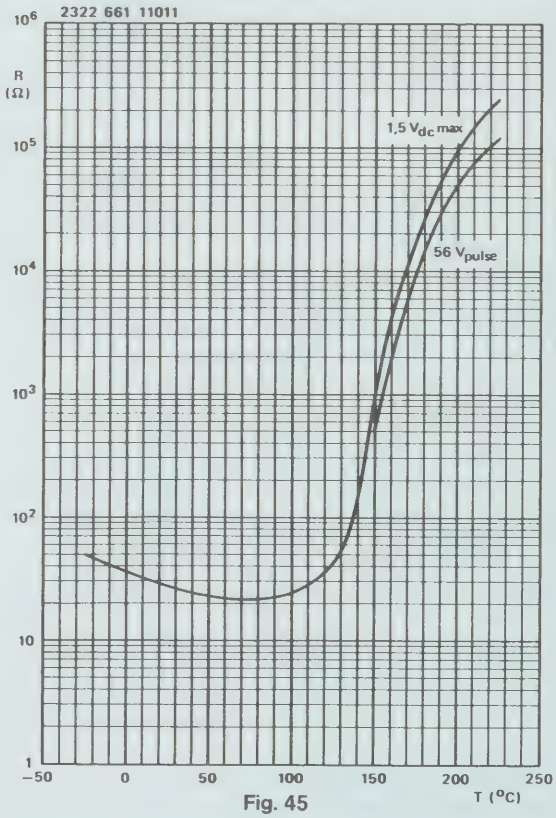

Fig. 45

Typical resistance/temperature characteristics.

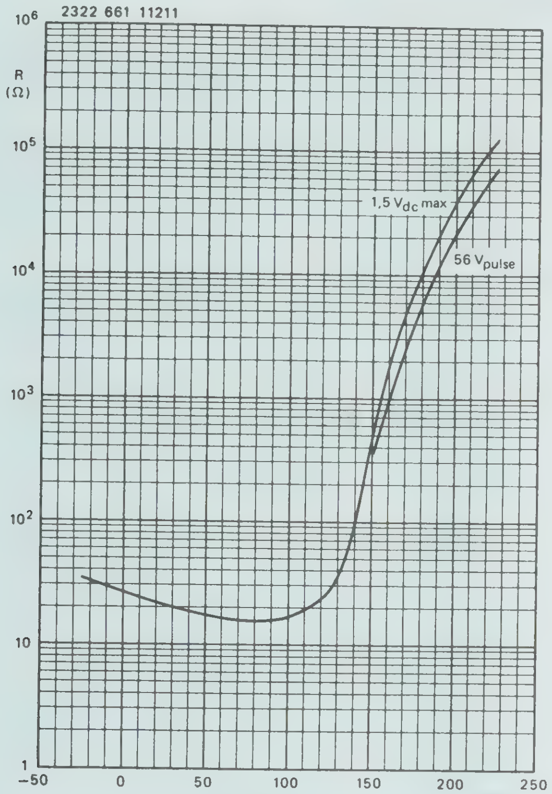

Fig. 46

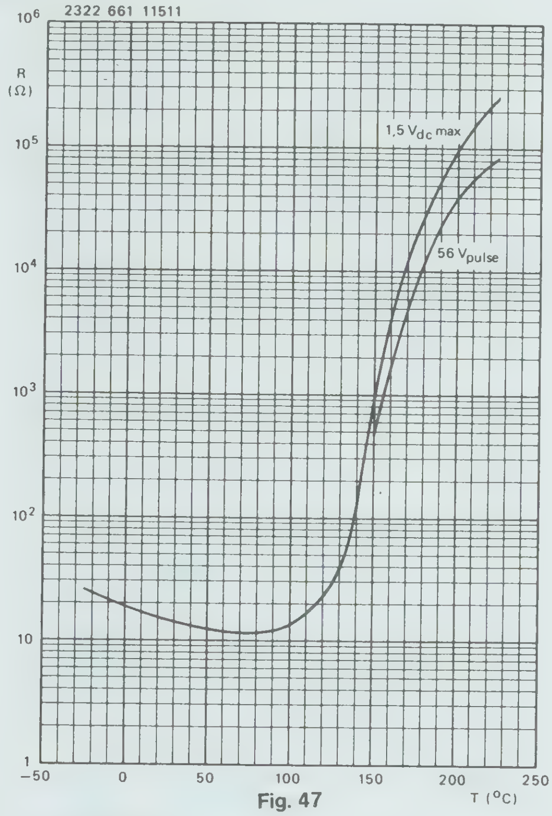

Fig. 47

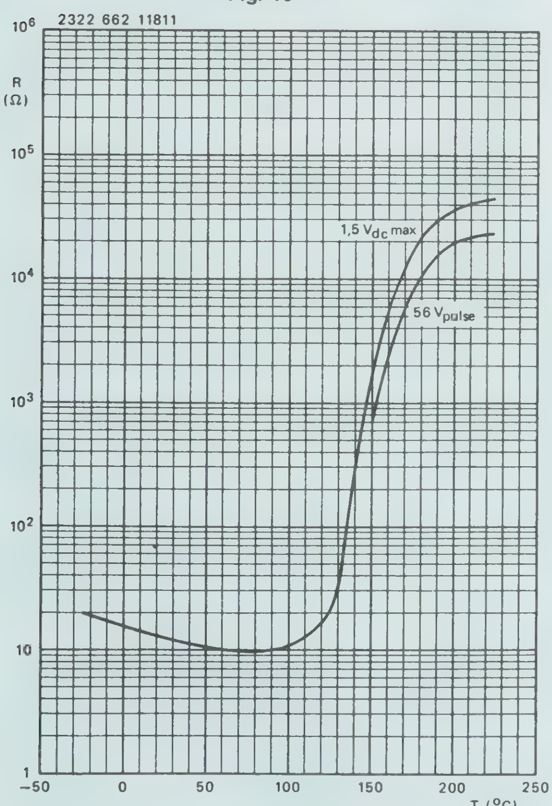

Fig. 48

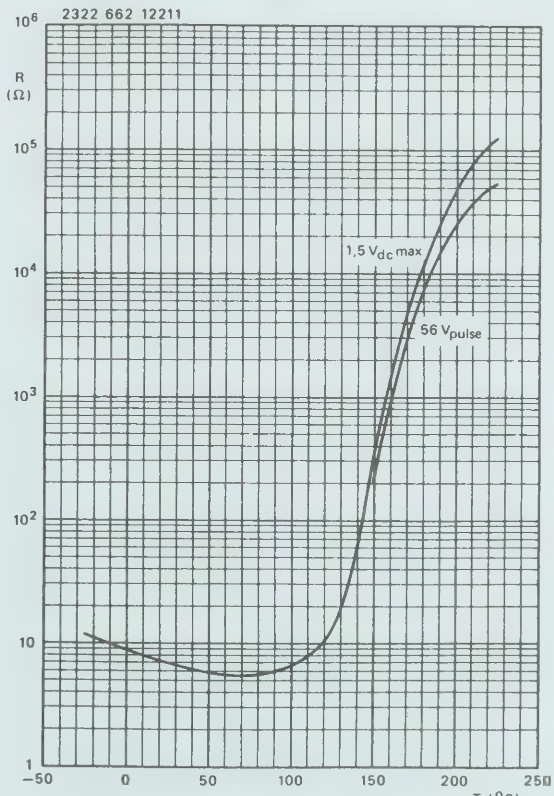

Fig. 49

Current Overload Protection

Typical resistance/temperature characteristics.

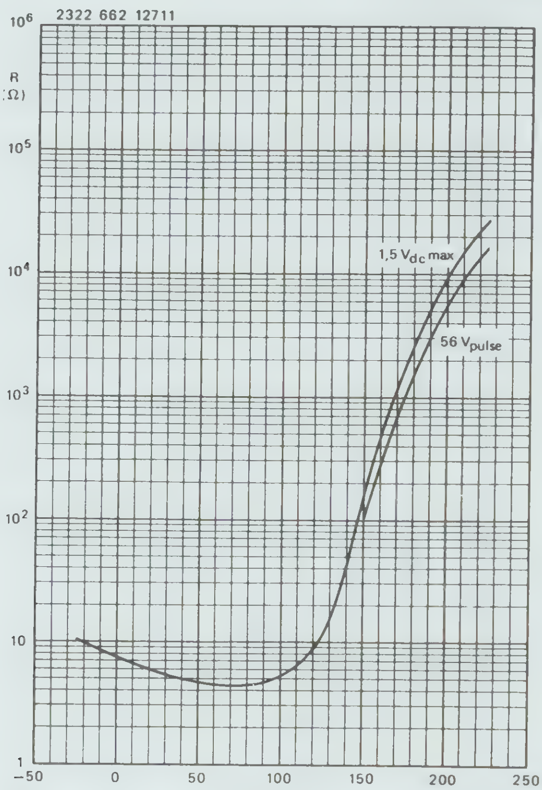

Fig. 50

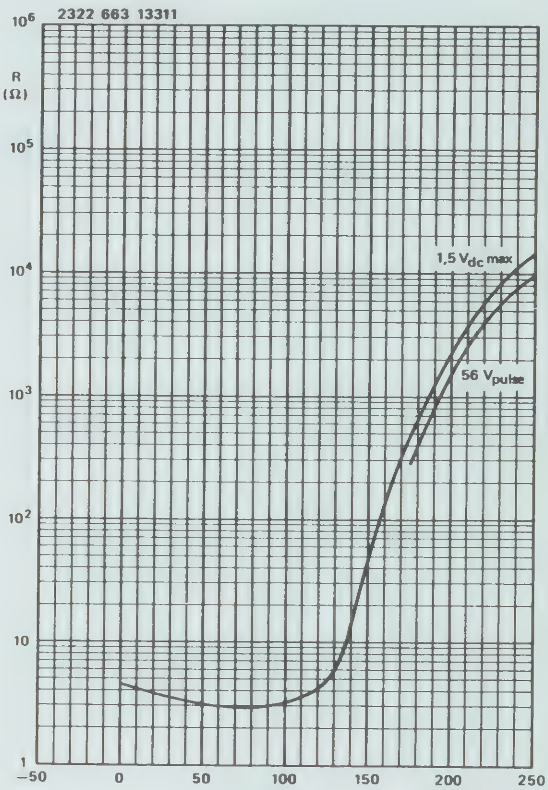

Fig. 51

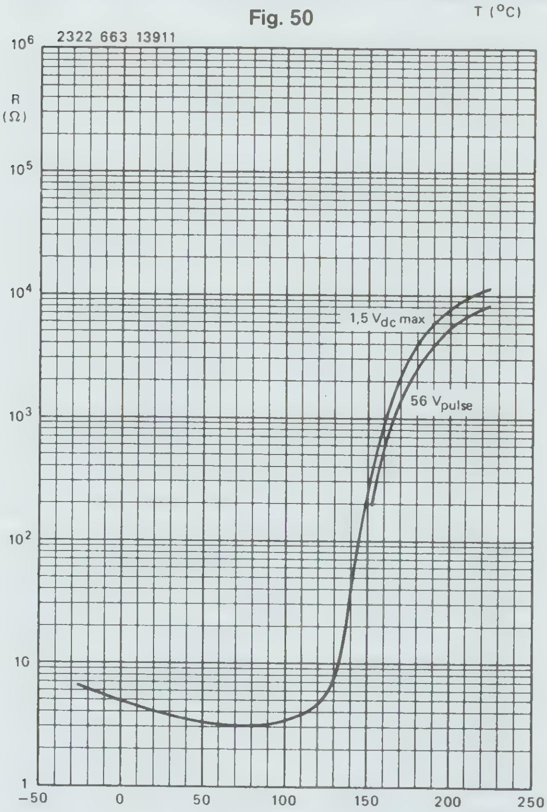

Fig. 52

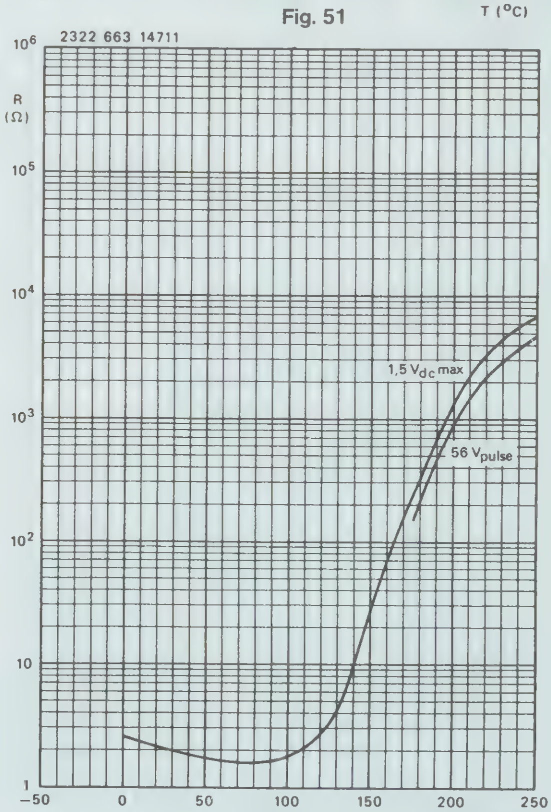

Fig. 53

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Typical resistance/temperature characteristics.

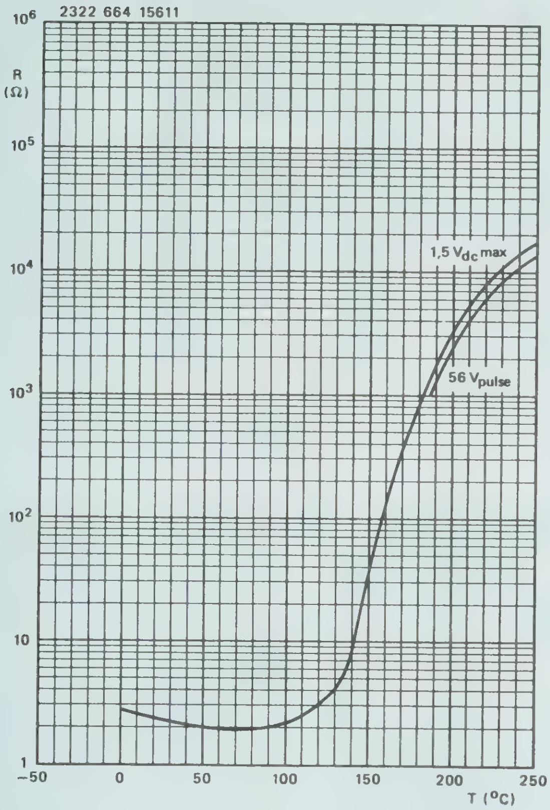

Fig. 54

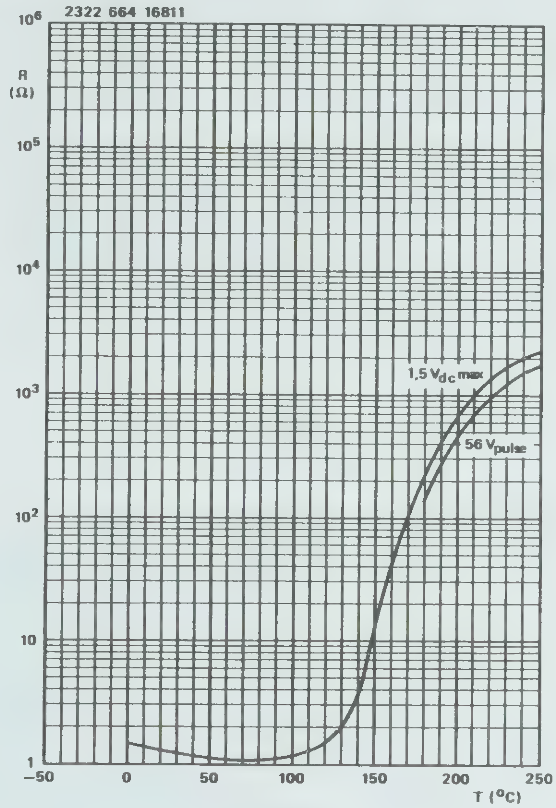

Fig. 55

Typical voltage/current characteristics.

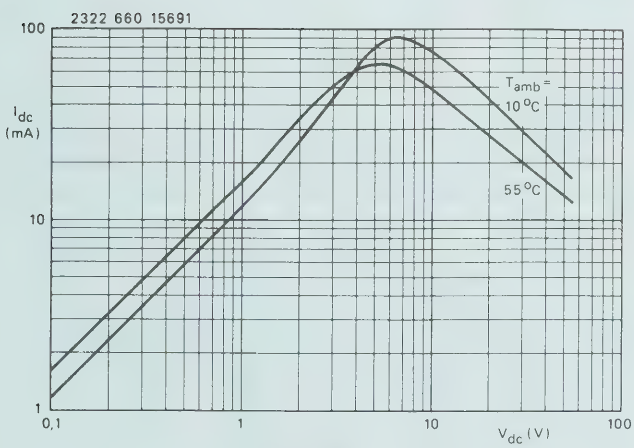

Fig. 56

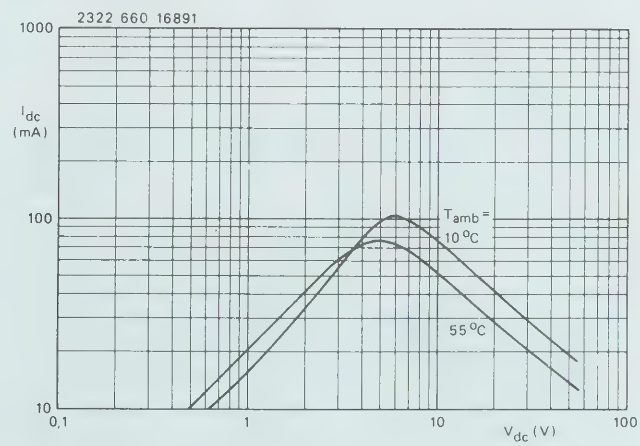

Fig. 57

8
Non-Linear Resistors

Typical voltage/current characteristics.

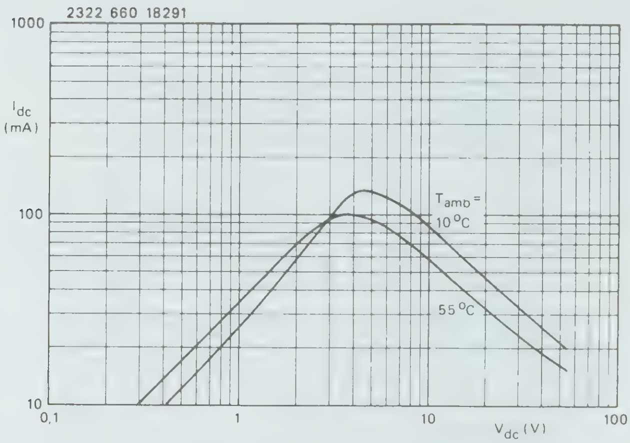

Fig. 58

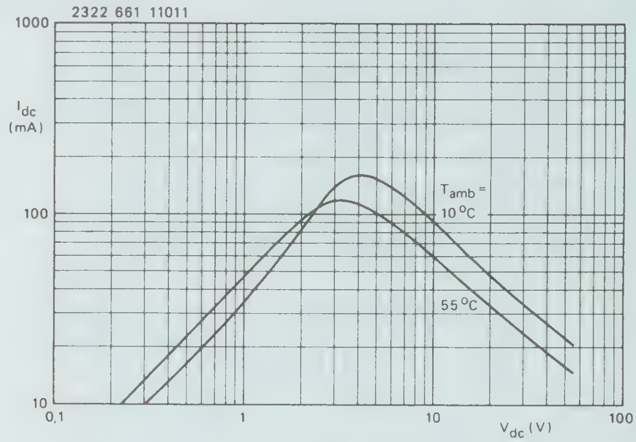

Fig. 59

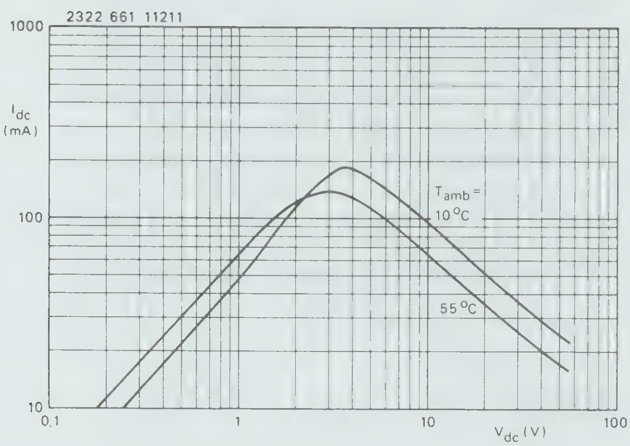

Fig. 60

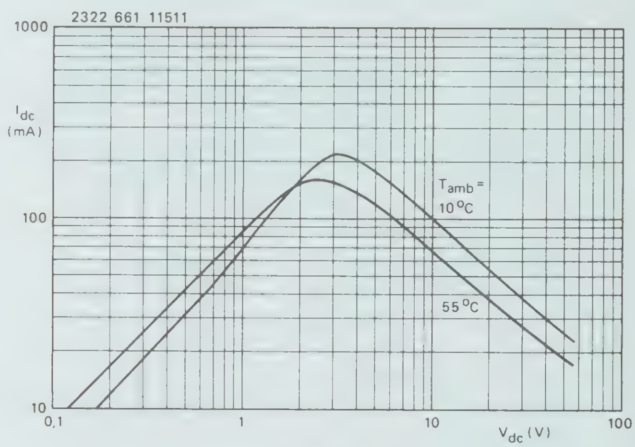

Fig. 61

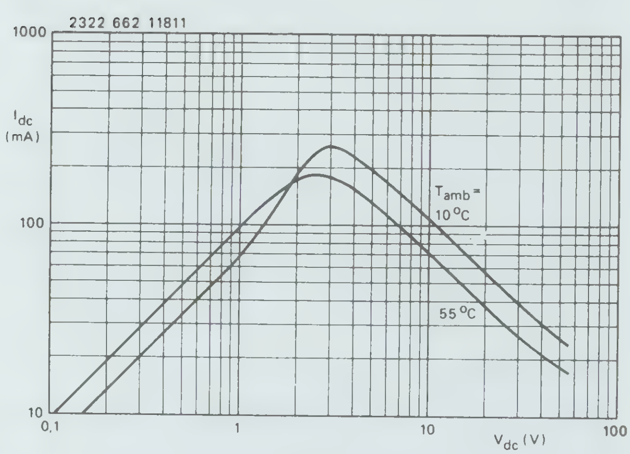

Fig. 62

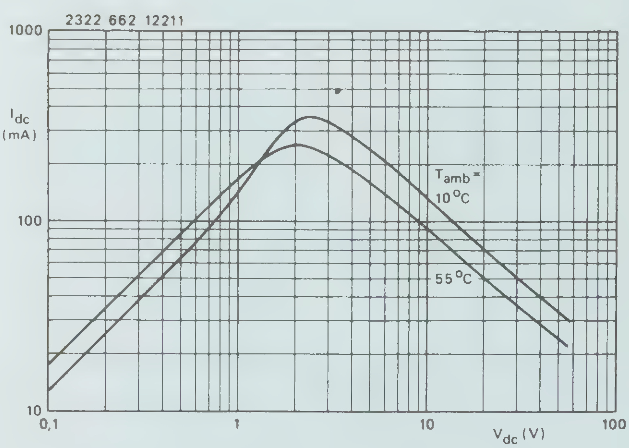

Fig. 63

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Typical voltage/current characteristics.

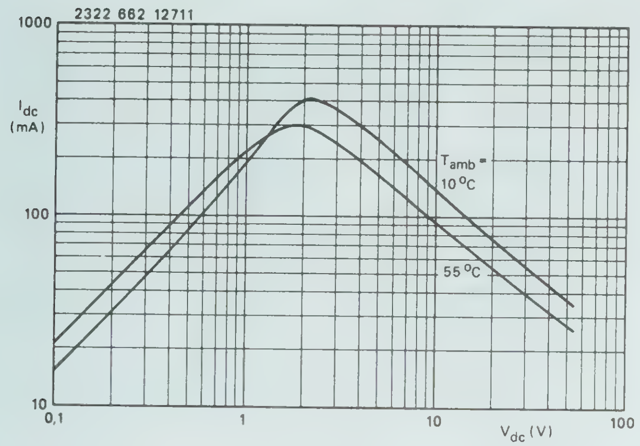


Fig. 64

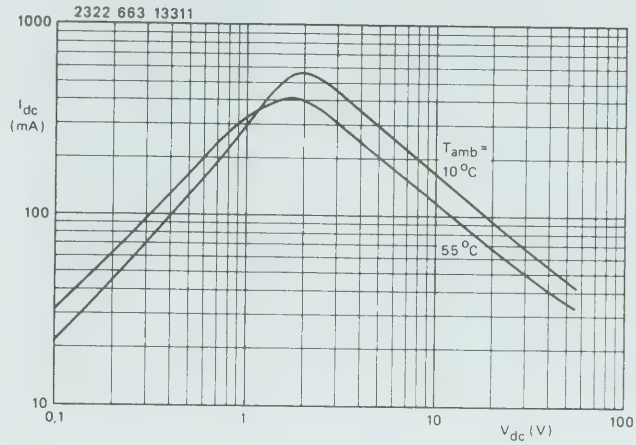


Fig. 65

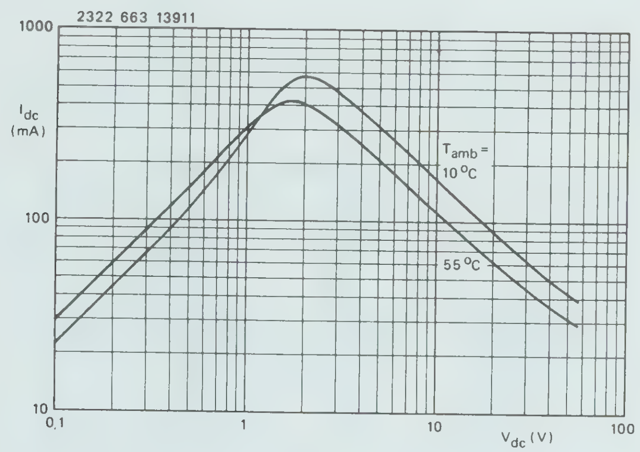


Fig. 66

SERIES 66.
Current Overload Protection

Typical voltage/current characteristics.

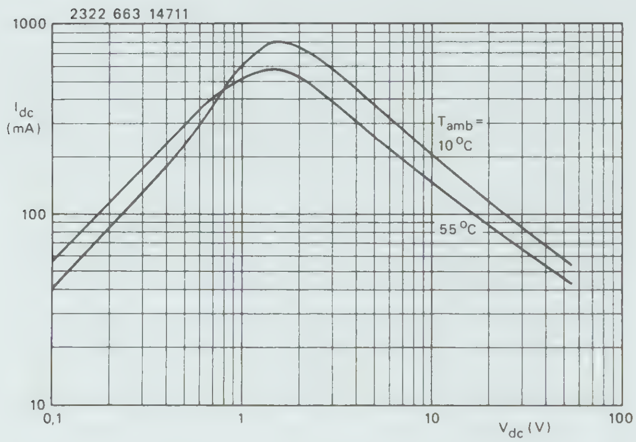


Fig. 67

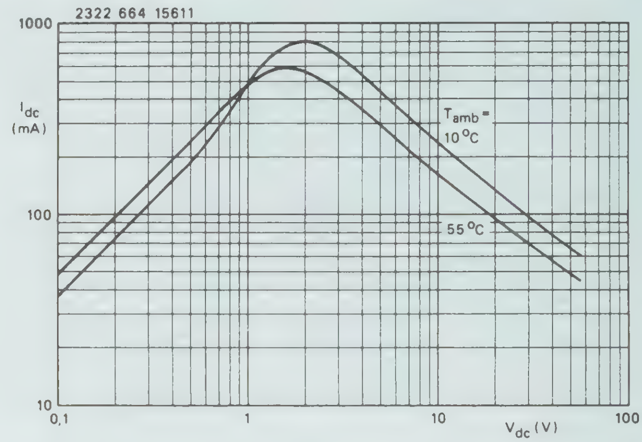


Fig. 68

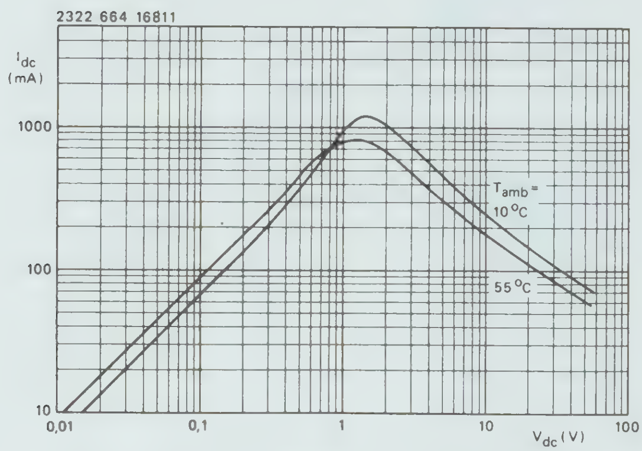


Fig. 69

8 Non-Linear Resistors

SERIES 680-04

PTC Heaters Assemblies UL File E 60558

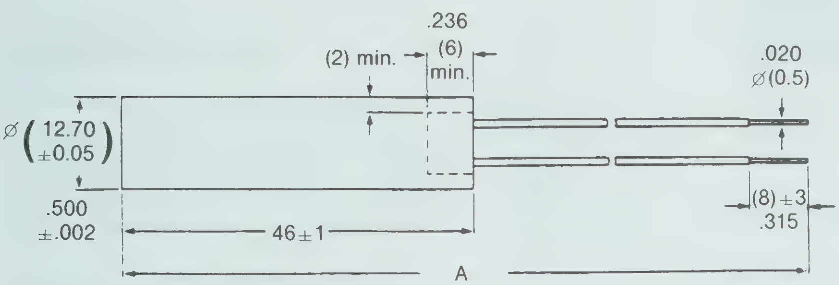
DESCRIPTION

The Series 680-04 PTC Heater Assemblies are encapsulated and are provided with two single-core insulated silver plated copper wires.

ELECTRICAL SPECIFICATIONS

Minimum Dielectric Withstanding Voltage	4000 VRMS
Operating Temperature	At zero power −25°C to +85°C at maximum voltage 0° to +55°C
Maximum In Rush	1000 Watts

MECHANICAL DATA—Inches (mm) Outlines



Robustness of Terminations
Tensile Strength 2.25 lb (10N)
Bending 1.12 lb (5N)

Solderability
240°C, Max 6 Seconds

Impact
Free fall 39.4" (1000 mm)

Non-flammable

Mass
Approx 15 grams

Marking
Red Body. Leads are color coded per table

Lead Wire PTFE
Thermax 24-XTO-124 UL Style 1180

Mounting
In any position by soldering or damping suitable for mounting in a tube .502 ± .002 (12.76 ± .05) Diameter

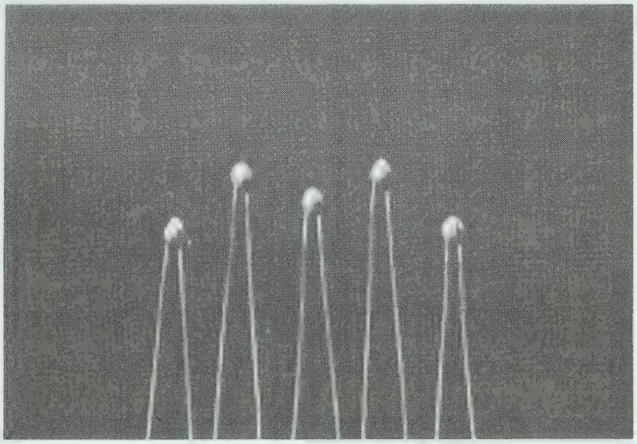
SERIES 680-04

2322– Part Number	Voltage (VRMS) 50/60 Hz	(°C) Temperature after 20 minutes at Voltage (VRMS)	Minimum (°C) Temperature at 5 minutes at Voltage (VRMS)	Operating power (watts) after 20 minutes at Voltage (VRMS)	Lead Colors	Dimensions A Inches (mm)
680-04003	100 to 265	160±12 @ 220V	130 @ 220V	130 @ 220V	Red/Red	8.268±.197 (210±5)
680-04004	100 to 145	160±12s @ 120V	130 @ 120V	13 @ 120V	Red/Black	8.268±.197 (210±5)
680-04005	100 to 145	210 @ 120V	165 @ 120V	17 @ 120V	Orange/White	6.535±.157 (166±4)
680-04033	100 to 265	210 @ 220V	165 @ 220V	17 @ 220V	Orange/White	6.535±.157 (166±4)
680-04034	100 to 265	210 @ 220V	165 @ 220V	17 @ 220V	Orange/White	4.370±.157 (111±4)
680-0400	100T .265	215±12 @ 220V	170 @ 220V	18 @ 220V	Red/Red	8.268±.197 (210±5)
680-04002	100T .145	215±12 @ 120V	170 @ 120V	18 @ 120V	Red/Black	8.268±.197 (210±5)
680-04022	100T .265	220± @ 220V	180 @ 220V	19 @ 220V	Red/Red	4.921±.197 (125±5)

8 Non-Linear Resistors

Disc PTC Thermistors for General Applications

18% to 38%/°C Temperature Coefficient 30 to 250Ω at 25°C
70° to 150°C Switch Temperature 25 Volts maximum



DESCRIPTION

Series 672 General-Purpose Thermistors are rugged, lightweight, miniaturized units, available with or without leads, for accommodation of the widest possible range of industrial, commercial, and consumer applications.

DESIGN FEATURES

- **Choice of Nine Switch Temperatures** in 10°C increments from 70° to 150°C.
- **High Temperature Coefficients** for high detection sensitivity. 18% to 38%/°C, for standard types.
- **Wide Operating Temperature Range,** from −25°C to as high as +190°C.
- **Very Small Size.** Less than 9/64″ in diameter. Leadless types are even smaller.

TYPICAL APPLICATIONS

- **Overvoltage and Short Circuit Protection.** Connected in series with a load circuit, the thermistor limits the load current to a safe value.
- **Current Stabilization for Constant Load.** Paralleled with a resistor, in series with the load, the thermistor compensates for slow voltage fluctuations.
- **Thermostatic Control.** Permits establishing and maintaining temperatures in tanks, compartments, process vessels, home appliances, and feedback controls.
- **Fire Alarm Warning and Shutdown.** Protects against over-temperature by actuation of warning device and/or shut-down of power.

ELECTRICAL SPECIFICATIONS

Resistance at 25°C . . . . 30 to 250Ω
Resistance at T_S +5°C . . . . <550Ω
Resistance at T_S +15°C . . . . >1330Ω
Resistance at T_S +25°C . . . . >4000Ω
Switch Temperature (T_S)† . . . . . . 70° to 150°C
Maximum Voltage (V_{max}) . . . . 25V DC
Dissipation Factor . . . . 5.7 mW/°C
Thermal Time Constant . . . . 9 seconds
Operating Temperature Range
at zero power . . . . −25°C to T_S +40°C
at V_{max} . . . . T_S +25°C max.

Measuring voltage: ≤1.5 V to avoid self-heating.

TYPICAL ELECTRICAL CHARACTERISTICS

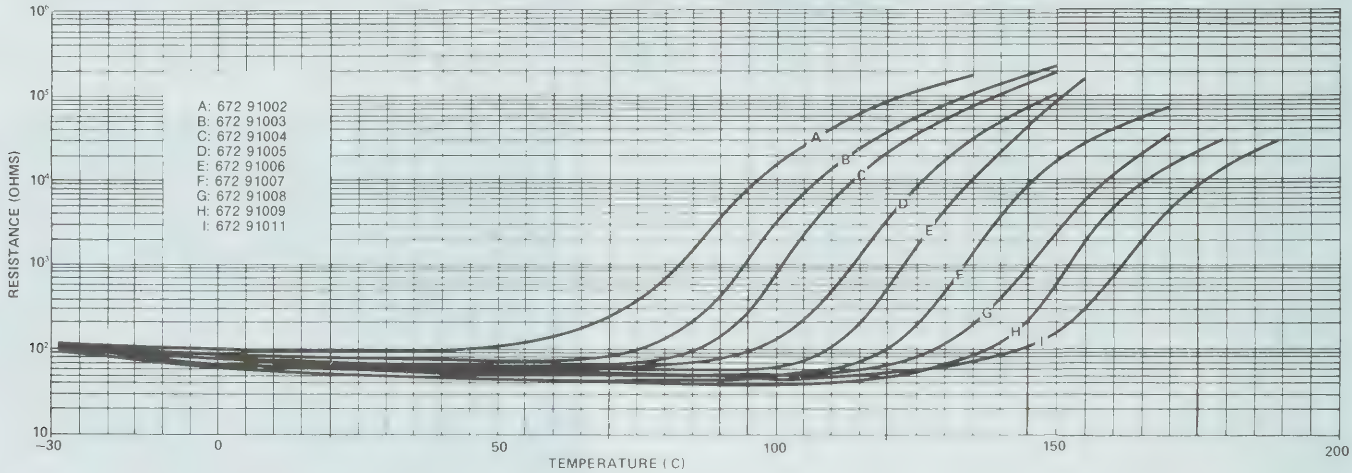
Nom. Res. at 25°C (Ω)	Switch† Temp. T_s (°C)	Temp. Coeff. (%/°C)	Color* Code	Part Number (2322-) With Leads	Part Number (2322-) Leadless
92	70	+18	Violet	672-91002	672-91026
62	80	+21	Gray	672-91003	672-91027
60	90	+31	White	672-91004	672-91028
62	100	+33	Black	672-91005	672-91029
57	110	+38	Brown	672-91006	672-91031
62	120	+27	Red	672-91007	672-91032
70	130	+33	Orange	672-91008	672-91033
50	140	+33	Yellow	672-91009	672-91034
70	150	+23	Green	672-91011	672-91035

*Leadless version is not color coded.
†Upper temperatures at which the resistance is twice the minimum resistance.

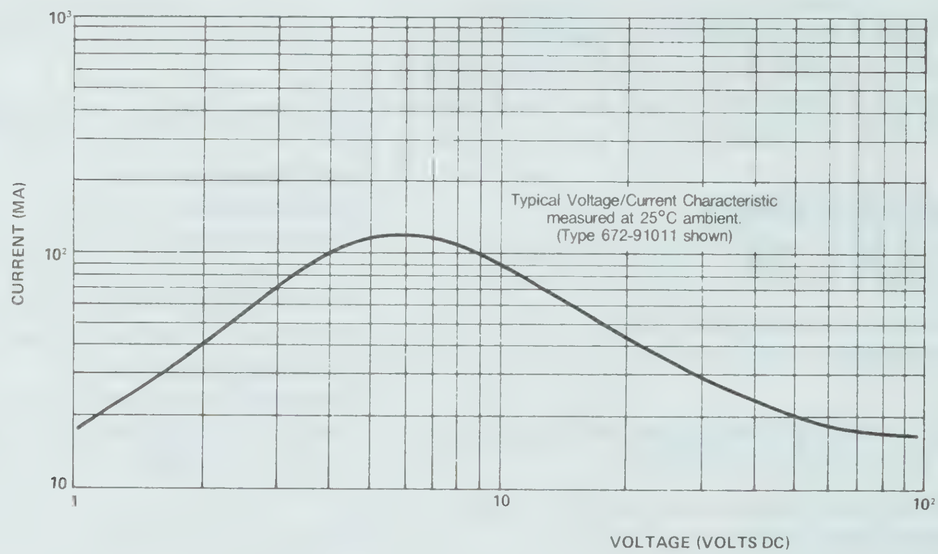
SERIES 672

Disc PTC Thermistors for General Application

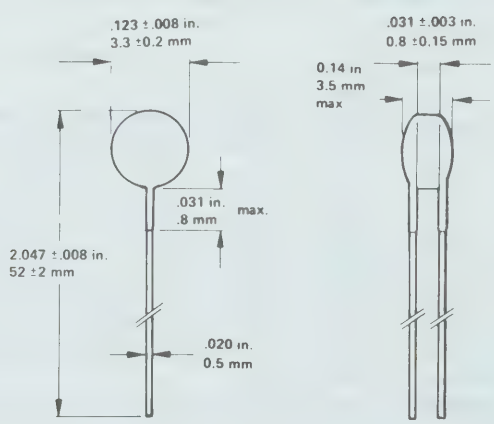
RESISTANCE vs TEMPERATURE



VOLTAGE vs CURRENT



DIMENSIONS AND MARKING



Types 672-91002 to 91011 are provided with tinned solid-copper leads.

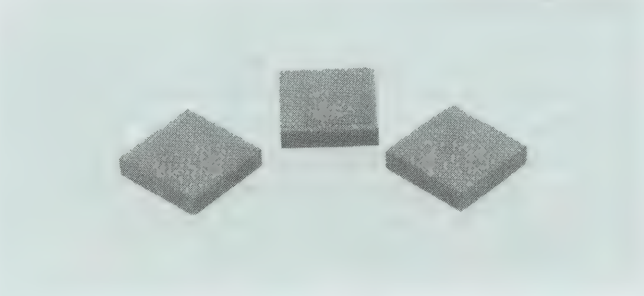
8 *Non-Linear Resistors*

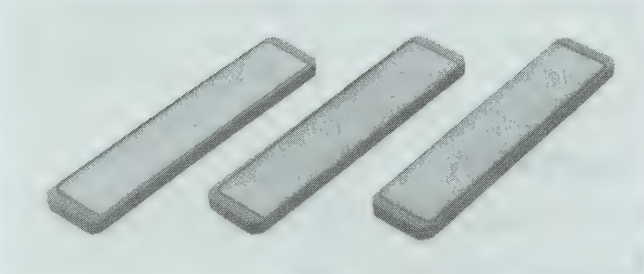
Philips Components • Airport Road, P.O. Box 760 • Mineral Wells, TX 76067 • (817) 325-7871 • FAX: (817) 325-1052

SERIES 680-93

PTC Heater Ceramics

UL File E60558





DESCRIPTION
The Series 680-93 PTC Heater Ceramics consist of a parallelepiped with two non-solderable electrical contacts.

APPLICATION
Ceramic heating elements for low power domestic and industrial applications and in thermally delayed switches which require the temperature to be stabilized

MECHANICAL DATA—Inches (mm)
Outlines

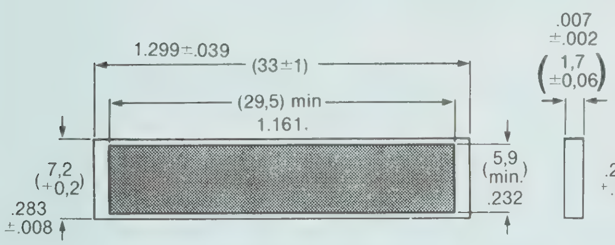


Fig. 1.

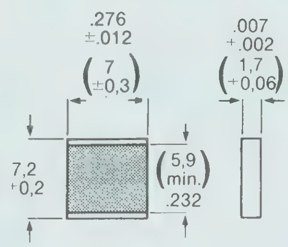


Fig. 2.

Flatness
.002 in. (50 μm) max.

Mounting
In any position by clamping.

Impact
Free fall 7.87 in. (200 mm)

Non-flammable.

ELECTRICAL DATA
Unless otherwise specified, measured according to IEC publication 738-1 of 1982.

Part number	resistance at ($50V_{pulse}$)			T_s*	maximum	dimensions	mass
	25°C	Switch Temp	Switch Temp +30°C	approx.	voltage	see Fig.	approx.
2322 680 followed by	±35% Ω	max. Ω	min. Ω	°C	r.m.s. V		grams
93021	850	2000	5000	115	265	1	2.25
93022	220	500	1250	145	265	1	2.25
93023	850	1500	4000	170	265	1	2.25
93024	300	300	750	200	265	1	2.25
93025	1700	850	2000	230	265	1	2.25
93026	2300	700	1750	245	265	1	2.25
93027	400	750	2000	170	145	1	2.25
93028	680	350	800	240	145	1	2.25
93029	3650	8600	21500	115	265	2	0.46
93031	950	2200	5400	145	265	2	0.46
93032	3650	8600	21500	170	265	2	0.46
93033	1300	1300	3250	200	265	2	0.46
93034	7300	3600	8600	230	265	2	0.46
93035	9900	3000	4300	245	265	2	0.46
93036	1720	3250	8600	170	145	2	0.46
93037	2900	1500	3450	240	145	2	0.46

* T_S = switch temperature

SERIES 691

Relative Humidity Sensor

DESCRIPTION

This capacitive humidity sensor consists of a plastic film, both sides of which are coated with gold, thus forming a capacitor element. The dielectric constant of the film changes as a function of relative humidity in the atmosphere. As a consequence, the capacitance value of the sensor is a function of relative humidity.

The plastic film is clamped between spring contacts and packaged in a plastic housing.

The sensor's characteristics are not affected by contact with water but acetone vapor exposure should be avoided.

FEATURES

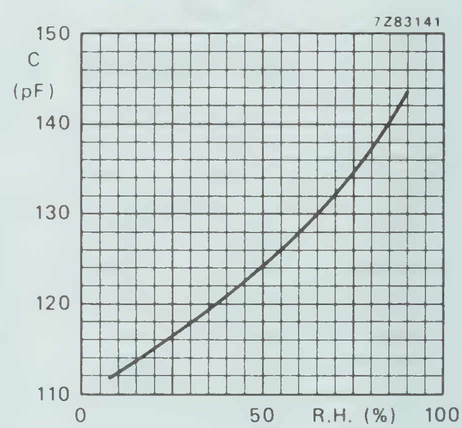
- Wide relative humidity range, 10 to 90%
- Cost effective accuracy
- Operating temperature range, 0 to 85°C
- Undamaged by condensation
- Operating frequency range, 1KHz to 1MHz

SPECIFICATIONS

ELECTRICAL

Operating Humidity Range	10 to 90% R.H.
Operating Temperature Range	0 to 85°C
Capacitance at 25°C, 43% R.H., 100KHz	122pF ±15%
Dissipation Factor at 25°C 100KHz	3.5% max.
Frequency Range	1 KHz to 1MHz
Temperature Dependence	0.1% R.H./°C
Response Time (to 90% of indicated R.H. at 25°C, in circulating air)	
Between 10 and 43% R.H.	3 minutes max.
Between 43 and 90% R.H.	5 minutes max.
Typical Hysteresis (excursion of 10 to 90 to 10% R.H.)	3%
Maximum Voltage	15V
Storage Humidity Range	0 to 100% R.H.
Storage Temperature Range	−25 to 85°C

TYPICAL CAPACITANCE & R.H. CURVE



MECHANICAL

Assembly	Sensor can be soldered onto P.C. board or mounted with screws.
Solderability	240°C for 4 seconds max.
Lead Strength	2 lb. pull test with no damage.

Capacitive humidity sensor

The need has long been felt for an electronic humidity sensor that is both reliable and inexpensive. Surprisingly, these requirements are not easily met, and until recently the only devices that could be considered reliable were far too costly for widespread use. Electronic humidity sensors have many advantages.

- they can be incorporated directly into an electrical measuring circuit, so avoiding many of the problems often associated with their mechanical counterparts
- they are highly versatile and can be used to drive a variety of humidity display and humidity control appliances
- they are generally easier to operate and to maintain than mechanical sensors
- they are easier to calibrate

Our new capacitive humidity sensor (type number 2322 691 90001; Ref. 1) possesses all these advantages and combines them with very low price.

The sensor, shown in Fig. 1, consists of a perforated plastic case containing a stretched membrane of non-conducting foil, coated on both sides with gold. The membrane and coating form respectively the dielectric and electrodes of a parallel plate capacitor whose capacitance C_s depends upon the ambient relative humidity H_{rel} as shown in Fig. 2. The sensor is connected to a circuit that generates a d.c. voltage which is used to activate a meter, LED or liquid crystal display for directly indicating H_{rel}, or which acts as a monitoring signal for a humidity controller.

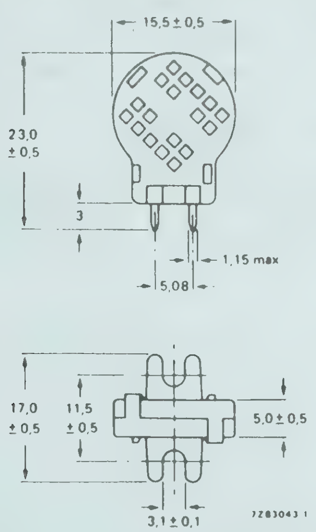


Fig. 1 Capacitive humidity sensor; dimensions in mm.

Designed for an operating range between 10% and 90% relative humidity, the sensor has a nominal accuracy (in circuit) of about 5% in the middle of its range under worst case conditions. Under normal conditions i.e. at room temperature and with nominal supply voltage, the errors will obviously be less than this.

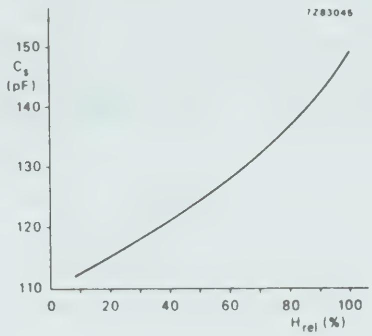


Fig. 2 Relationship between relative humidity H_{rel} and sensor capacitance C_s.

Most air pollutants have little effect on the performance of the sensor. However, vapours of some solvents, such as acetone, will attack the foil, and should be avoided when handling the sensor or incorporating it in an assembly.

The table gives just some of the many applications for which the sensor is suited. Although it is not a precision measuring instrument, it is a highly versatile, reliable and inexpensive device that is certainly accurate enough for its intended applications.

We now describe a circuit for generating an output signal proportional to H_{rel}.

Some applications for which the capacitive humidity sensor is suited.

indication	control
home hygrometers	air conditioners
weather stations with LED or LCD displays	humidifiers in factories and in the home
	climate controllers in greenhouses
	tumble dryers (i.e. detecting when a load is dry)

Capacitive humidity sensor

MEASURING CIRCUIT

The circuit operates by measurement of pulse-width differences, the principle of which is shown in Fig. 3. It has two synchronized multivibrators M_1 and M_2, connected respectively to a trimmer capacitor C_T and to the humidity sensor of capacitance C_s. Capacitance C_s comprises a constant contribution C_o and a contribution ΔC dependent upon H_{rel}, i.e. $C_s = C_o + \Delta C$.

Multivibrators M_1 and M_2 produce pulses of duration t_1 and t_2 proportional to C_T and C_s respectively (Fig. 4). The pulse width difference t_3 is equal to $t_2 - t_1$.

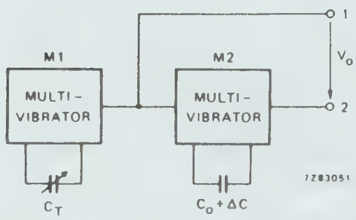


Fig. 3 Operating principle of the measuring circuit. The circuit generates pulses with durations proportional to trimmer capacitance C_T and to sensor capacitance $C_s = C_o + \Delta C$. If C_T is set equal to C_o, then the pulse width difference is proportional to ΔC, i.e. to the humidity-dependent capacitance.

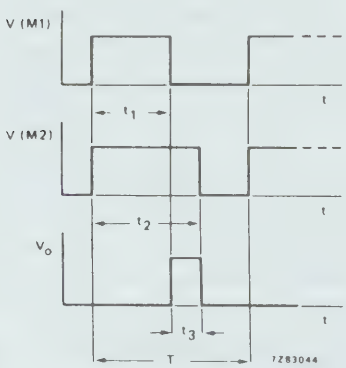


Fig. 4 Formation of pulses in the circuit of Fig. 3.

If M_1 and M_2 have equal proportionality contants and C_T is equal to C_o, t_3 will be proportional to ΔC. If the pulse frequency is set at 1/T, where $T = 2t_1$ (Fig. 4) and all pulses have equal amplitude V_B, then the mean output voltage will be:

$$\overline{V}_o = (t_3/T)V_B = (\Delta C/2C_o)V_B.$$

The term t_3/T is called the *relative pulse width.* Its temperature and voltage dependence are very small provided:

- the characteristics of both multivibrators are identical (constructed for example from a single LOCMOS circuit HEF4001B);
- C_s and C_T have equal temperature coefficients.

Output voltage $\overline{V}_o$ is directly related to the supply voltage which should therefore be stabilized for best results.

Practical circuit

Figure 5 shows a design based upon two integrated LOCMOS circuits HEF4001B. Depending upon its application the circuit may be either battery or mains powered.

Multivibrators M_1 and M_2 are each formed by a pair of NOR gates in the first LOCMOS circuit. 10 kHz pulses produced by M_1 and M_2 are fed to the second LOCMOS circuit which produces a pulsed output voltage with an average value $\overline{V}_o$ proportional to the pulse width difference. The four NOR gates of this circuit are connected in parallel to provide low output impedance. An RC network in the supply line suppresses parasitic oscillations in the circuit.

Linearizing network

Because the relation between C_s and H_{rel} is non-linear, the pulsed output signal $\overline{V}_o$ is fed to a linearizing network; for explanation this is shown separately in Fig. 6. Voltage pulses charge capacitor C via diode D and resistor R_1. At the same time a discharge current proportional to the voltage across the capacitor flows through resistor R_2, and an additional current flows from the supply line via resistor R_3. The output voltage V'_o is thus a non-linear function of $\overline{V}_o$, and with suitable choice of C, R_1 and R_2, this function can be so profiled that the relationship between H_{rel} and V'_o is made substantially linear.

In the circuit of Fig. 5, the output voltage can vary between 80 mV and 1 V. This voltage can be used either to indicate or to control relative humidity.

Capacitive humidity sensor

C1 = 3 to 40 pF		2222 808 11409
C3 = C2 = 47 pF	P100	2222 632 04479
C4 = 22 pF	P100	2222 632 04229 (optional)
H = HUMIDITY SENSOR		2322 691 90001

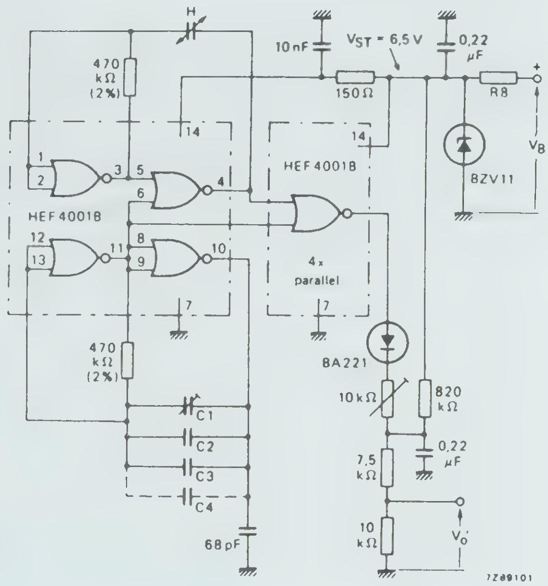


Fig. 5 Measuring circuit with linearized output. The circuit is suitable for connection to an external power supply. In this circuit R_8 is chosen so that $R_8 \approx (V_B - V_{ST})/2$ mA Ω.

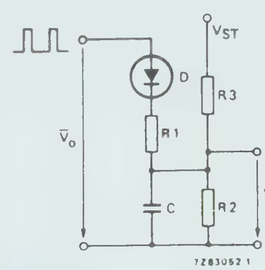


Fig. 6 Linearizing network used in Fig. 5.

Component layout of the measuring circuit shown in Fig. 5. (including a stabilized power supply)

Capacitive humidity sensor

APPLICATIONS

Humidity indication
Indicator with LED pointer display

A pointer display is one in which one element in a row lights up to indicate the instantaneous value of some quantity. The mains powered device described here uses a 16-element LED pointer display to indicate H_{rel} between 20% and 90%, the scale being divided into intervals of 5%.

Figure 7 shows the circuit. It uses a display IC UAA170 to drive the LEDs, the linearized output voltage V'_o of the measuring circuit being fed to the display IC via an operational amplifier which acts as a voltage follower with a gain of 2. This prevents the measuring circuit from being loaded with the input impedance of the display IC, and also amplifies V'_o to the required input voltage.

Resistors R_1, R_2 and R_3 are chosen such that:

- the change-over between one LED and another is smooth (1,2 V between adjacent pins);
- LED 1 lights at a relative humidity of 20% (200 mV at pin 3 of IC NE532);
- LED 16 lights at a relative humidity of 95% (950 mV at pin 3 of IC NE532).

Note: the spread in the internal reference voltage (i.e. voltage at pin 14) may make it necessary to replace R_3 by a 47 kΩ potentiometer.

This device indicates the relative humidity with an LED pointer display. Each LED covers a 5% interval of H_{rel}.

Fig. 7 Relative humidity indicator with an LED pointer display.

Capacitive humidity sensor

Bargraph with liquid crystal display

This device uses the output voltage V'_0 of the measuring circuit to drive a relative humidity bargraph with a liquid crystal pointer display. The device performs two functions: it indicates instantaneous relative humidity between 15% and 90% (either in pointer or in bargraph mode), and it indicates the peak value.

Figure 8 shows the circuit. A voltage follower with gain (NE532) amplifies the output from the measuring circuit to the required input voltage of a bargraph driver (HEF4754 V) that drives an 18-element liquid crystal display. As in the previous example, the scale is divided into 5% intervals.

The maximum and minimum readings of the display must be preset by applying fixed voltages of 3,55 V and 0,53 V to pins 27 and 26 respectively. The circuit consumes about 3 mA which is rather high for battery operation. Nevertheless it can operate satisfactorily on 5 rechargeable NiCd batteries.

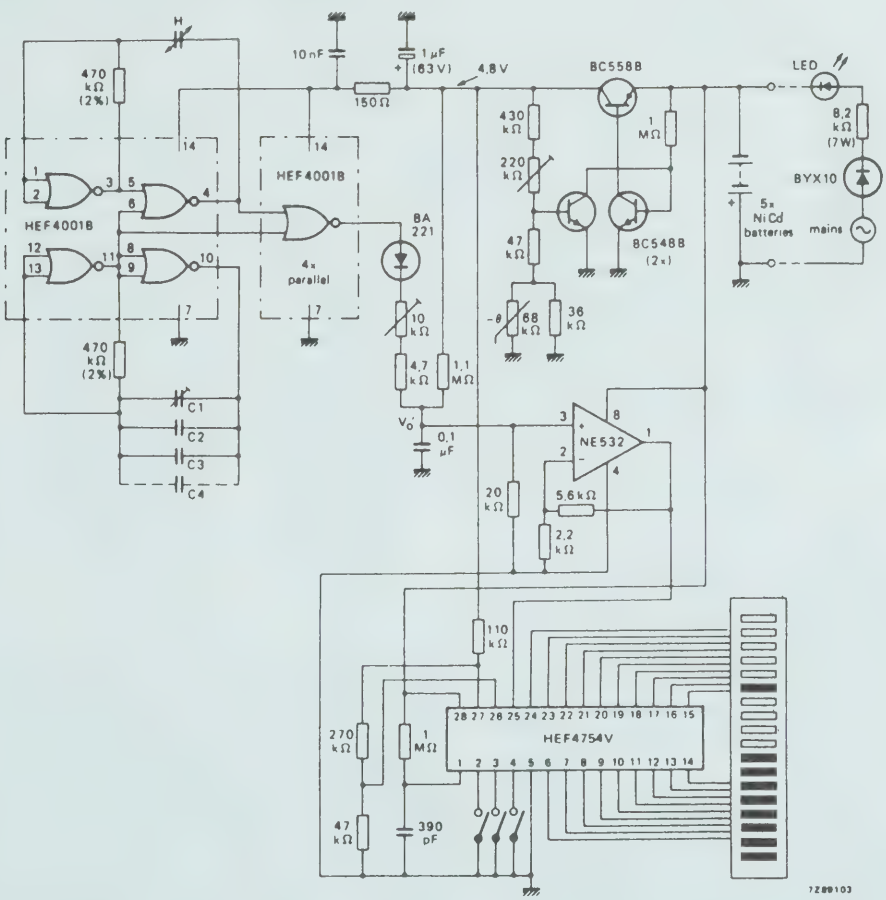


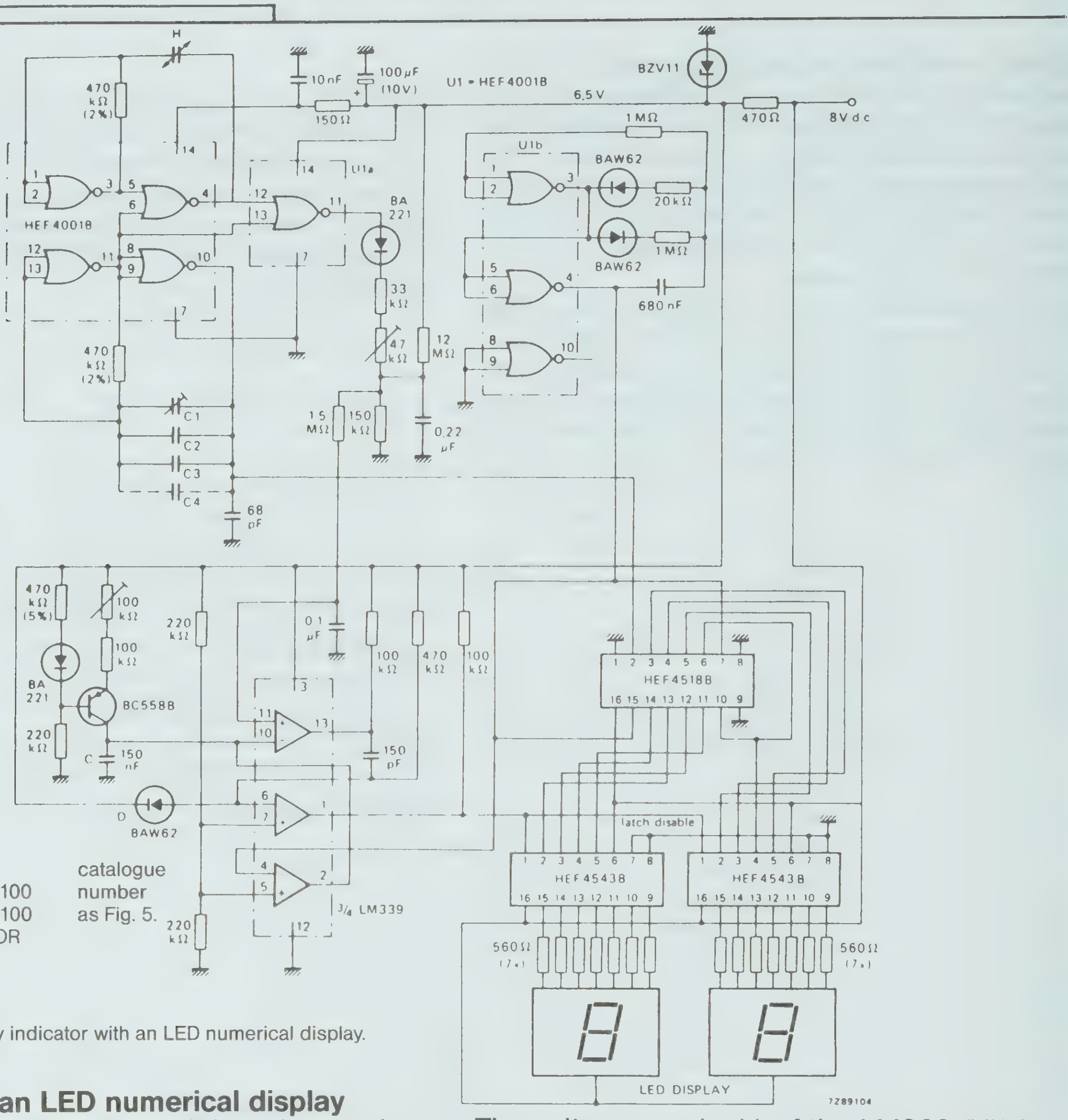
Fig. 8 Relative humidity bargraph with a liquid crystal display. The system shows ambient relative humidity as well as the peak value. Switching positions as follows:

- pins 2, 3 and 4 open: peak indication, reset by connecting pin 2 to common for a few seconds.
- pin 4 open, pin 3 common: no peak indication.
- pins 3 and 4 common: pointer mode.

C1 = 3 to 40 pF		catalogue
C3 = C2 = 47 pF	P100	number
C4 = 22 pF	P100	as Fig. 5.

H = HUMIDITY SENSOR
68 kΩ NTC thermistor
2322 642 12683

Capacitive humidity sensor



C1 = 3 to 40 pF
C3 = C2 = 47 pF P100
C4 = 22 pF P100
H = HUMIDITY SENSOR

catalogue number as Fig. 5.

Fig. 9 Relative humidity indicator with an LED numerical display.

Indicator with an LED numerical display

Somewhat more complicated than the previous device, this indicator employs a digital display to indicate H_{rel} between 10% and 90%.

The circuit, shown in Fig. 9, uses a dual BCD counter HEF4518B that receives clock pulses from a 10 kHz source, for example multivibrator M_1. Positive-going pulses from a third multivibrator (also produced from a LOCMOS HEF4001B circuit), are fed simultaneously to the reset pins of the counters and to pin 4 of a voltage comparator LM339. Figure 10a shows the pulse train.

With a positive-going pulse on pin 4 of the LM339 the voltage at pins 2 and 10 falls, capacitor C discharges over the duration of the pulse (i.e. 15 ms) and then recharges to produce the voltage waveform shown in Fig. 10b. Also, the end of each pulse lifts the counter reset, allowing counting of the clock pulses to begin.

The voltage on pin 11 of the LM339 (V_o') is proportional to H_{rel}. As capacitor C recharges, the voltage on pin 10 increases until it equals and eventually exceeds that at pin 11, producing at pin 13 a rectangular pulse whose duration depends on H_{rel} (Fig. 10c). This pulse is differentiated to produce at pin 6 two instantaneous pulses: a positive-going pulse conducted to the supply line via diode D, and a negative-going pulse that produces a corresponding positive-going pulse at pin 1 (Figs 10d and 10e). This final pulse, which marks the instant the voltages on pins 10 and 11 are equal, de-activates the latch-disable mechanism of two LED display ICs (HEF4543B) allowing them to receive the instantaneous count of the BCD counter. This count, which is a measure of H_{rel}, then shows as a two digit display, allowing H_{rel} to be read directly.

Relative humidity and temperature indicator with liquid crystal numerical display

This device, powered by four 1,5 V batteries, uses a liquid crystal numerical display to indicate the ambient relative humidity and temperature.

In common with the previous example, the circuit, shown in Fig. 11, uses an LM339 voltage comparator as an analogue/digital converter. Figure 12 illustrates the operation of the system.

Negative-going pulses (Fig. 12a) produced by a third multivibrator (also formed from an HEF4001B) are fed simultaneously to transistors TR_1 and TR_2, and to the reset pins of three HEF4518B counter ICs. The pulse on transistor TR_1 (pnp) causes it to conduct, allowing power to be delivered from the supply line to the major part of the circuit. Since this occurs only over the duration of the pulse, a considerable saving in power results. The pulse on transistor TR_2 (npn) causes it to become non-conducting, permitting capacitor C to charge and produce a ramp voltage (Fig. 12b) at pins 4, 7 and 10 of the voltage comparator. Finally, the pulse delivered to each counter IC lifts its reset and permits it to commence counting.

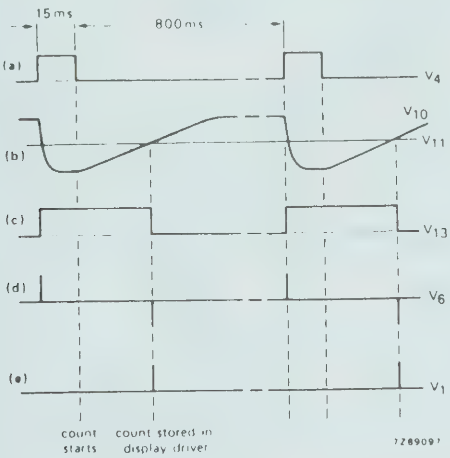


Fig. 10 Sequence of pulse trains produced in the circuit of Fig. 9.

Two of the counter ICs (the first being dedicated to the temperature section and the second to the humidity section) are fed 5 kHz pulses derived from a 50 kHz multivibrator (HEF4069B) via a pre-counter produced from the third counter IC.

Humidity section

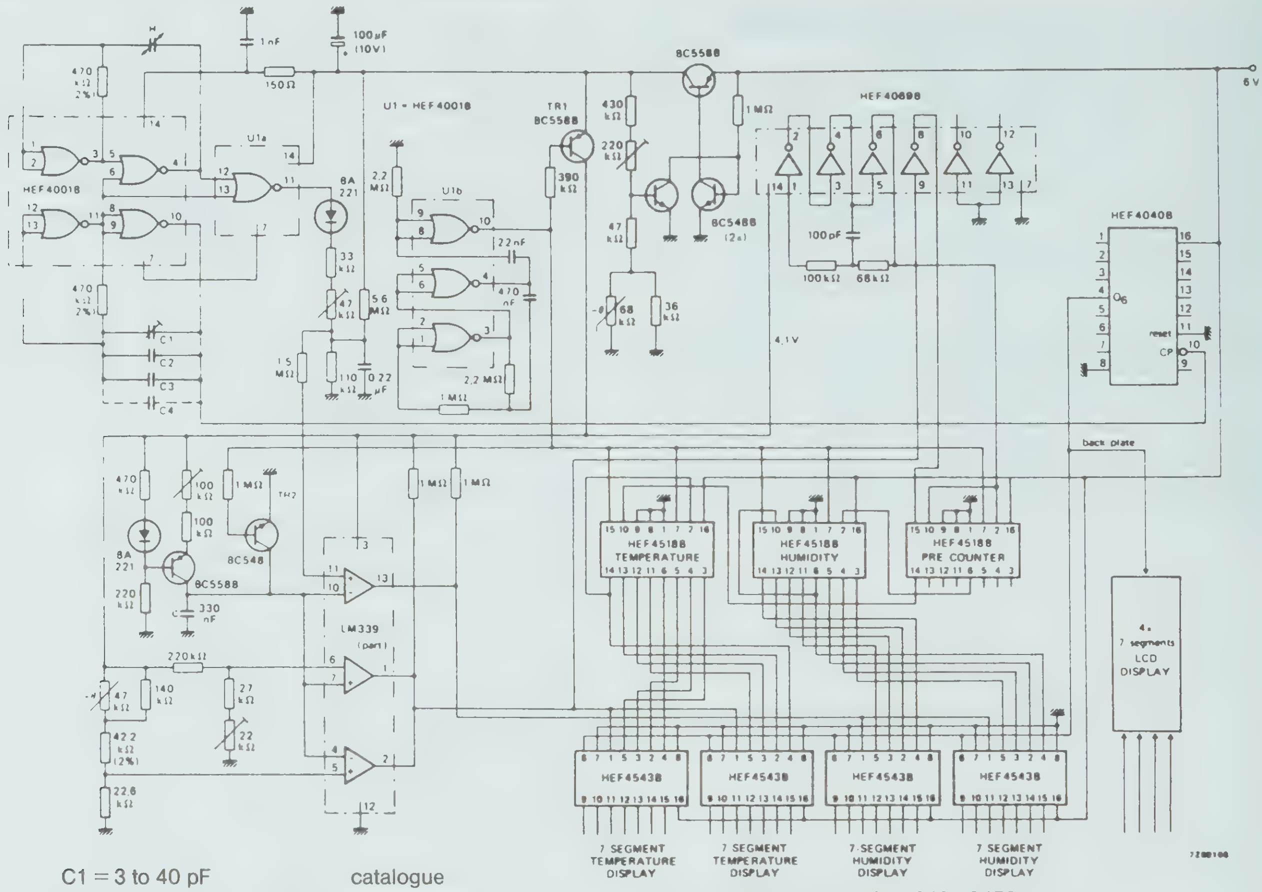
Voltage V'_o (proportional to H_{rel}) is applied to pin 11 of the voltage comparator (Fig. 12b). By comparing this voltage with the ramp voltage at pin 10, the comparator produces a positive-going pulse at pin 13 whose duration is proportional to H_{rel} (Fig. 12c). The pulse de-activates the latch-disable mechanisms of two 7-segment liquid crystal display drivers (HEF4543B) which then receive and display the instantaneous counts of the second counter IC (Fig. 11). At the end of the pulse, the latch-disable mechanisms are re-activated and the final count, which indicates H_{rel}, remains on display until the following pulse arrives.

Temperature section

The system caters for ambient temperatures between 0°C and 50°C, the temperature dependent signal being derived from an NTC thermistor. The system must therefore incorporate an offset to set the reference temperature at 0°C.

Pin 5 of the comparator receives a temperature dependent voltage governed by the thermistor, and pin 6 receives a constant offset voltage (Fig. 12b). With the ramp voltage applied to pins 4 and 7, a positive-going pulse occurs at point 0 (Fig. 11) whose duration is proportional to the temperature in °C. The pulse is inverted and fed to one half of the pre-counter, ensuring that the count transmitted to the first counter IC takes place only over the pulse duration (i.e. the interval between t_1 and t_2 in Fig. 12f). At the same time the pulse acts upon two liquid crystal display drivers (HEF4543B), allowing them to receive and display the count of the first counter IC to give a direct temperature reading.

Capacitive humidity sensor



C1 = 3 to 40 pF — catalogue
C3 = C2 = 47 pF P100 — number
C4 = 22 pF P100 — as Fig. 5.
H = HUMIDITY SENSOR

47 kΩ NTC thermistor, 2322 642 12473
68 kΩ NTC thermistor, 2322 642 12683

Fig. 11 Relative humidity and temperature indicator with a liquid crystal numerical display.

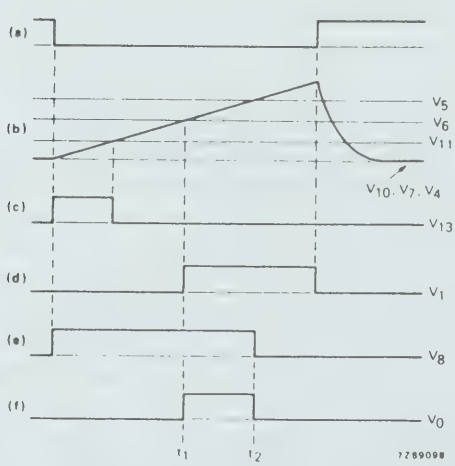


Fig. 12 Sequence of pulse trains produced in the circuit of Fig. 11.

C1 = 3 to 40 pF — catalogue
C2 = C3 = 47 pF P100 — number
C4 = 22 pF P100 — as Fig. 5.
H = HUMIDITY SENSOR
VDR = Voltage dependent resistor 2322 594 72512

Capacitive humidity sensor

Humidifier control

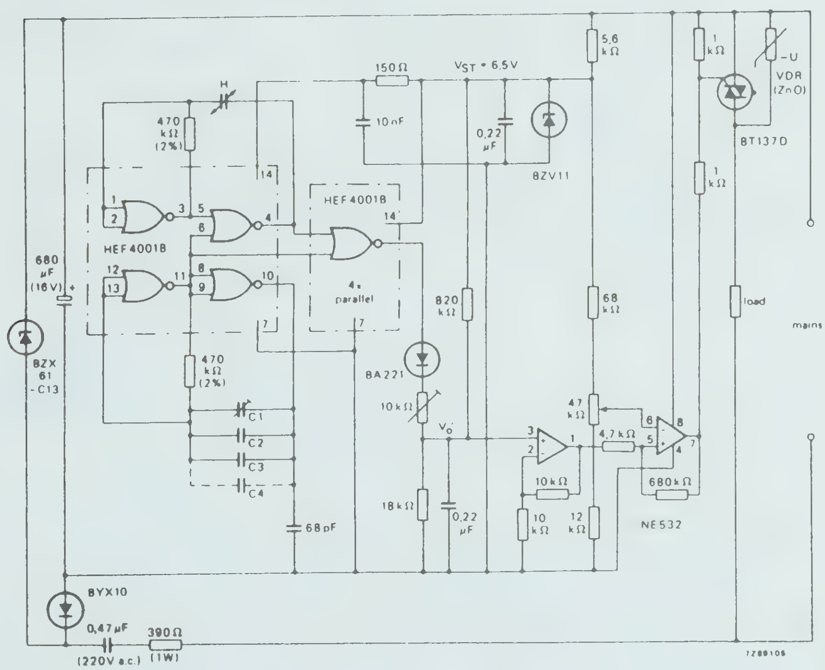
Humidifiers work by controlling the rate of water evaporation from a reservoir, either by regulating the water temperature with an electric heater or by blowing air over a moist wick with an electric fan. Two modes of operation are possible:

- *on-off control,* which can be used to control either a heater or a fan;
- *time-proportional control,* which can be used only for a heater.

Humidifier using on-off power control

Figure 13 shows the circuit. The output voltage V'_o of the measuring circuit is fed to a dual operational amplifier IC (NE532), the first op-amp of the IC acting exclusively as an amplifier (with a gain of 2) and the second op-amp acting as a voltage comparator.

The reference voltage (pin 6) of the comparator can be adjusted between 600 mV and 3000mV, giving a range in the preset values of H_{rel} between 20% and 100%. A triac (BT137D) controlled directly by the comparator, regulates power to the heater or fan. The use of negative d.c. control current allows the triac to operate in its most sensitive triggering quadrant. D.C. triggering allows, moreover, the use of both inductive and resistive loads.



C1 = 3 to 40 pF catalogue
C2 = C3 = 47 pF P100 number
C4 = 22 pF P100 as Fig. 5.
H = HUMIDITY SENSOR
VDR = Voltage dependent resistor 2322 594 72512

Fig. 13 Humidifier with *on-off* power control.

The circuit consumes a total current (including the triac triggering current) of 13 mA at 12 V d.c., the power being derived from the mains via a capacitive mains dropper (saving the expense of a transformer). Power for the measuring circuit comes from the 12 V d.c. via a resistor and 6,5 V voltage reference diode.

Capacitive humidity sensor

Humidifier using time-proportional power control
On-off power control has the advantage of simplicity, but this is offset to some extent by its tendency to overshoot. *Time-proportional control,* the principle of which is shown in Fig. 14, provides more accurate power regulation.

Power is delivered in a series of bursts of controlled duration and with a fixed repetition period. This period equals that of the sawtooth waveform shown in Fig. 14. By varying the reference voltage, we control the duty factor and hence the mean power delivered to the load. To eliminate r.f. interference and transient distortion, switching occurs at zero crossing of the mains. Because of this the circuit is only suited to the control of resistive loads (i.e. humidifiers using heaters).

Figure 15 shows a humidifier circuit using a TDA1023 time-proportional control IC (Ref. 2). An NE532 op-amp amplifies the output V'_o of the measuring circuit and feeds it to one input (pin 7) of the TDA1023. A 47 kΩ potentiometer connected to the other input (pin 6) is used to preset the relative humidity at any value between 40% and 90%.

A 3,3 μF capacitor connected to pin 12 fixes the repetition period of the sawtooth generator (embodied in the TDA1023) at about 2 seconds, and resistors connected to pins 4 and 5 define the proportional band (i.e. the range over which there is proportional control).

Power for the measuring circuit is derived from the internal power supply of the TDA1023.

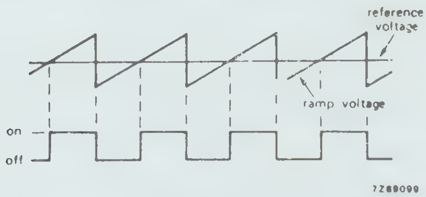


Fig. 14 Operating principle of time-proportional control. The duty factor (and hence the power delivered to the load) is varied by varying the *reference voltage.*

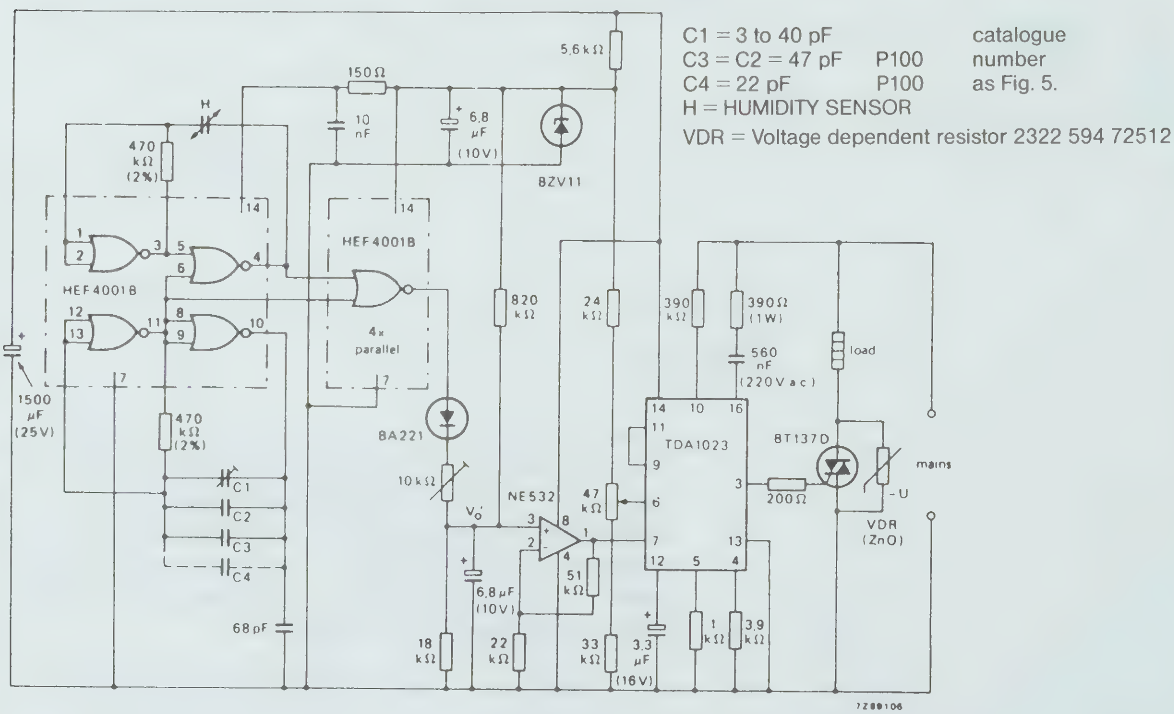
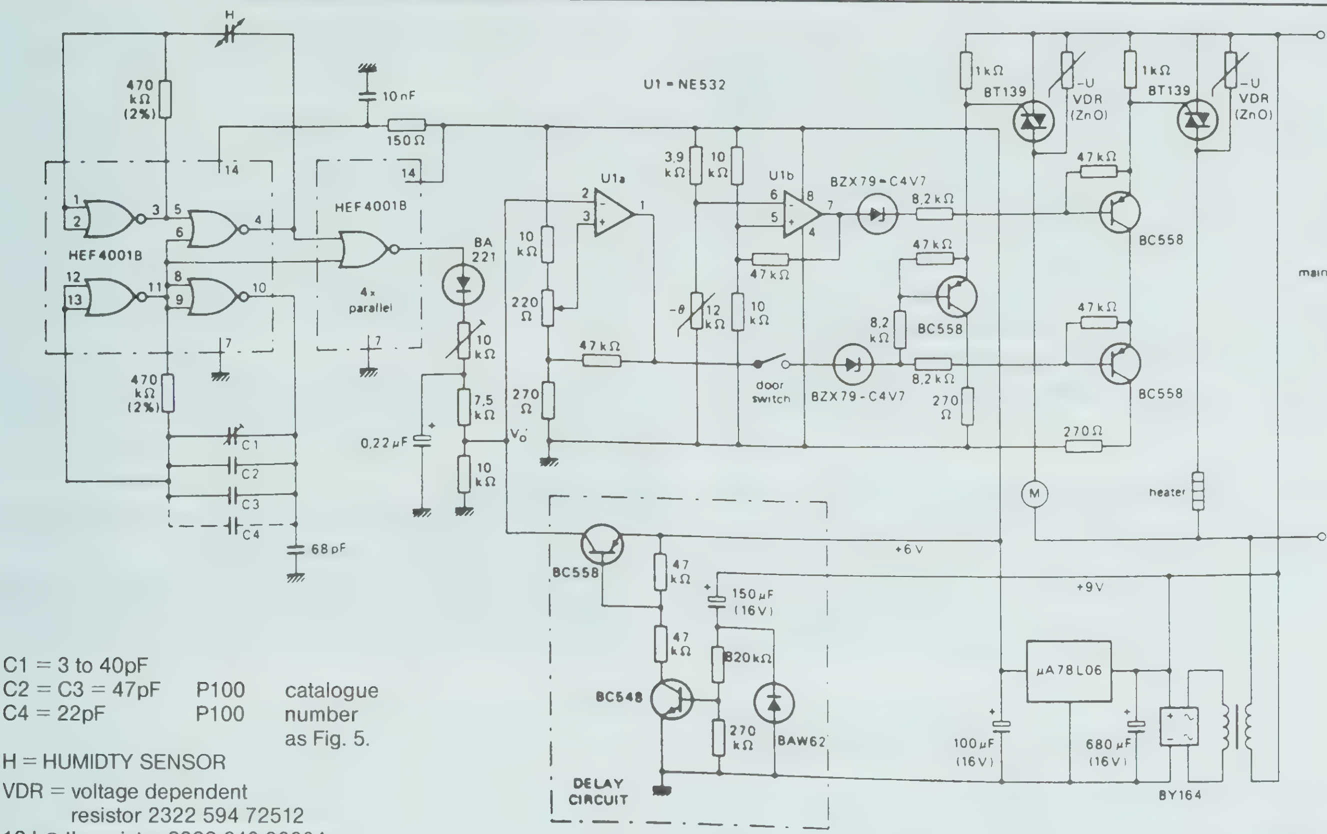


Fig. 15 Humidifier with *time proportional* power control. The circuit is only suited to the control of resistive loads (i.e. heaters).

Capacitive humidity sensor



C1 = 3 to 40pF
C2 = C3 = 47pF P100 catalogue number as Fig. 5.
C4 = 22pF P100
H = HUMIDTY SENSOR
VDR = voltage dependent resistor 2322 594 72512
12 kΩ thermistor 2322 640 90004

Fig. 16 Tumble dryer control based on the measurement of relative humidity in the air outlet of the dryer.

Capacitive humidity sensor

Tumble dryer control

A tumble dryer operates by heating a damp load whilst tumbling it slowly in a rotating drum. The relative humidity at the air outlet is a reasonable indication of how damp the load is. We can therefore use the measuring circuit to control the dryer, switching it off when the load has reached a preselected level of dryness.

Figure 16 shows a circuit for controlling a tumble dryer. As in previous examples the circuit operates by comparing V'_0 with a constant voltage, in this instance a preset voltage corresponding to the required level of H_{rel} (i.e. the level that indicates a dry load).

The humidity sensor is located in the air outlet of the dryer, and an NTC thermistor is located in the drum. The thermistor is used to control the air temperature within the drum, switching the heater off when the temperature exceeds 60°C and switching it back on when the temperature falls below 50°C.

The on-off switch is door-operated so that drying begins as soon as the door is closed, and stops whenever the door is opened.

When a damp load is inserted, the relative humidity inside the drum rises. It may not, however, rise enough to start the dryer operating. A delay circuit therefore holds V'_0 above the preset voltage for about 2 minutes after the door is closed. The dryer can then start and run for sufficient time for the humidity at the outlet to rise above the preset value, after which the operation is controlled by the humidity sensor.

Figure 17 shows how the relative humidity at the air outlet varies with time. The humidity increases as soon as the motor starts, then gradually falls until the load reaches the required level of dryness and the dryer switches off.

The circuit shown is a laboratory prototype and lacks some features that could be advantageous. For instance, to reduce creasing the heater should switch off slightly before the drum motor. A memory might also be included in the circuit to prevent the dryer switching on again when drying is complete (as might occur for example if the door were opened to remove the load and then closed without switching the dryer off at the mains).

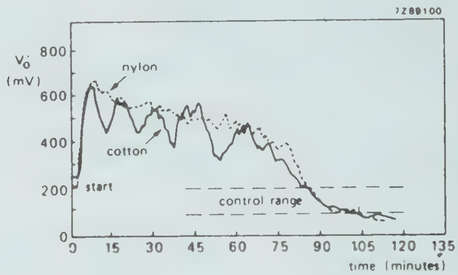


Fig. 17 The relative humidity in the outlet of a tumble dryer falls as the load dries. The curves here relate to a fully loaded standard domestic tumble dryer.

REFERENCES

1. Technical Note 134, capacitive humidity sensor for consumer applications.
2. Technical Information 025. Design of time proportional temperature controls using the TDA1023.

8 Non-Linear Resistors

CAPACITIVE HUMIDITY SENSOR FOR CONSUMER APPLICATIONS

Humidity sensors, as used for example in home hygrometers and in automatic humidity control systems, have two major requirements: predictable behaviour and good long term stability. In addition, such sensors should be ruggedly constructed for reliable operation under adverse conditions as well as being simple to operate and to maintain.

Our new capacitive humidity sensor (catalogue no. 2322 691 90001) which has been designed for measuring relative humidity H_{rel}, meets all the above requirements and combines them with very low price. It consists of a perforated plastic case (Fig. 1) containing a stretched membrane of non-conductive foil coated on both sides with gold, the membrane and coating forming respectively, the dielectric and electrodes of a parallel plate capacitor.

Changes in relative humidity bring about variation in sensor capacitance C_s. This in turn is converted by appropriate circuitry into a d.c. voltage that can be used to give a direct indication of relative humidity, or to serve as the monitoring signal of an automatic humidity control system. The sensor thus avoids the readout problems associated with mechanical devices in that it relies solely upon variation of an electrical parameter (i.e. capacitance) and hence can be incorporated directly into an electronic measuring circuit.

It is designed for a measuring range of H_{rel} between 10% and 90%, and possesses the advantage that its long-term characteristics are unaffected by condensation of water on the foil surface. Aggressive pollutants in the air have little effect upon performance, but it is important to note that the foil should not be exposed to the vapours of some solvents such as acetone.

The sensor should not be used in applications requiring a high degree of precision, e.g. scientific work. Indeed as we shall see later, its accuracy precludes such application.

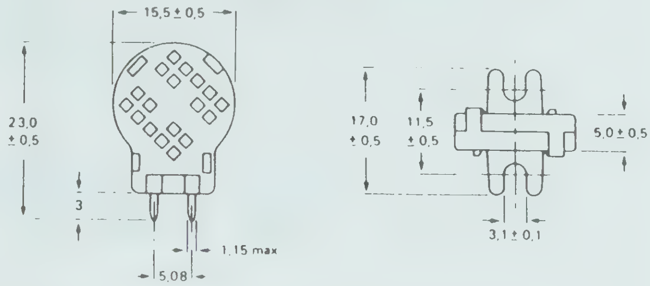


Fig. 1 Dimensional drawing of the humidity sensor. Dimensions in mm.

Capacitance C_s comprises a constant contribution C_o and a contribution ΔC dependent upon relative humidity, i.e. $C_s = C_o + \Delta C$. Figure 2 shows the dependence of C_s on H_{rel}, and it is evident that this dependence is quite marked. However, since the relationship is non-linear, to obtain a direct indication of humidity, either a non-linear scale must be employed or the output signal must be processed by a linearizing circuit.

The most obvious method of generating an output signal from the sensor is by means of a bridge network. Although this method yields good results in practice, it is somewhat expensive. In the following, we describe three inexpensive circuits for generating an output signal, all based upon the measurement of pulse width differences, the circuits exhibiting varying degrees of sophistication.

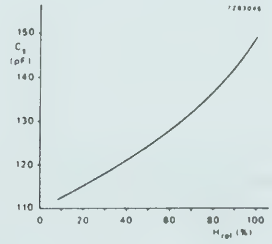


Fig. 2 Relationship between relative humidity H_{rel} and sensor capacitance.

Capacitive humidity sensor

MEASUREMENT OF PULSE WIDTH DIFFERENCES

The operating principle of a circuit based upon the measurement of pulse width differences is shown in Fig. 3.

The circuit comprises two synchronized multivibrators M_1 and M_2, the former connected to a trimmer capacitor C_T and the latter connected to the humidity sensor of capacitance C_s. M_1 and M_2 produce pulses of duration t_1 and t_2 proportional to C_T and C_s respectively. This is shown in Fig. 4. The pulse width difference t_3 is given by $t_3=t_2-t_1$. It is convenient to choose M_1 and M_2 with equal proportionality constants so that if C_T is adjusted to be equal to C_o, t_3 will be proportional to ΔC.

Choosing the pulse frequency to be 1/T, where $T=2t_1$ (see Fig. 4), and assuming that all pulses have equal amplitude V_B, then the mean output voltage will be:

$\overline{V}_o=(t_3/T)V_B=(\Delta C/2C_o)V_B$.

The temperature and voltage dependence of t_3/T are very small provided that:

- the characteristics of both multivibrators are identical (being constructed for example from a single LOCMOS circuit HEF4001B)
- C_s and C_T have equal temperature coefficients.

The output voltage $\overline{V}_o$ is directly related to the supply voltage which should therefore be stabilized for best results.

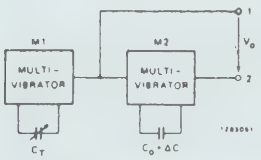


Fig. 3 Principle of circuit used for measuring pulse width differences.

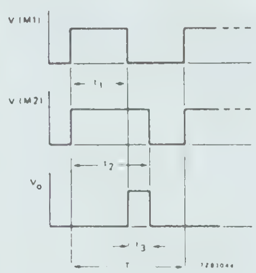


Fig. 4 Formation of pulses in the circuit of Fig. 4.

PRACTICAL CIRCUITS

Figure 5 shows a design based upon two integrated LOCMOS circuits HEF4001B. The circuit is battery powered with a supply voltage of 4,5 V and a current drain of about 0,1 mA. Multivibrators M_1 and M_2 are each formed by a pair of NOR gates in the first LOCMOS circuit. Pulses produced by M_1 and M_2 are fed to the second LOCMOS circuit which produces an output signal proportional to the pulse width difference, the four NOR gates of this circuit being connected in parallel to provide comparatively low output impedance. It is thus possible to connect a 50μA, 1kΩ meter to the output via a 22 kΩ potentiometer.

Capacitive humidity sensor

Table 1 gives the relationship between H_{rel} and pointer deflection, this being non-linear owing to the non-linear relationship between humidity and capacitance. This can be corrected, however, by appropriate circuit design (see below) thus permitting the use of a linearly divided scale.

A low value of trimmer capacitance C_4 facilitates accurate adjustment. Should this value prove too low, however, an additional capacitance of 22 pF (C_6) can be added.

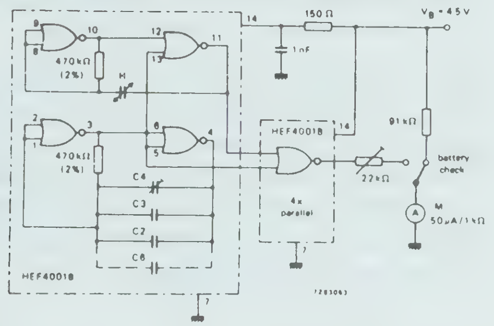
Parasitic oscillations in the circuit are suppressed by an RC network (150Ω, 1 nF). By increasing the capacitance in the RC network to 1μF, the circuit can be driven by a 3 V supply. Note, however, that at this lower supply voltage accuracy will decrease considerably.

This comparatively simple circuit is inexpensive, its operation is reliable and its accuracy is sufficient for many applications. If it is fed by two or three pen-light elements, continuous operation for about one year is possible.

Figure 6 shows a more elaborate circuit comprising a stabilized supply voltage and a linearizing circuit.

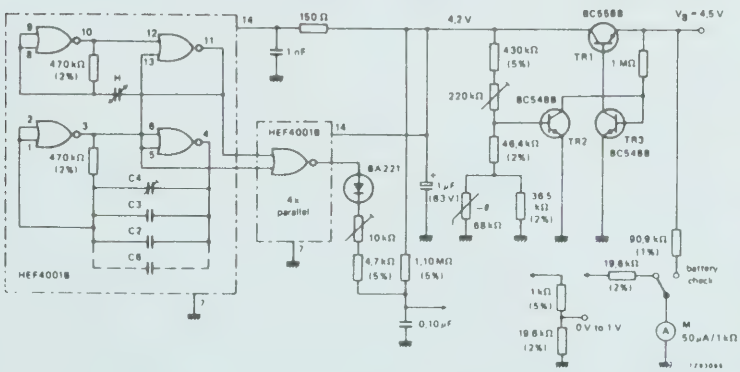
TABLE 1 Relationship between H_{rel} and the required subdivision of the meter scale

H_{rel} (%)	0	10	20	30	40	50	60	70	80	90	100
deflection (%)	0	6,6	13,22	20,5	29,0	36,8	46,0	56,6	67,6	81,6	100



C2 = C3 = 47pF P100 2222 632 04479
C4 = 3 ... 47pF 2222 808 11409
C6 = 22pF P100 2222 632 04229 (optional)
H = HUMIDITY SENSOR 2322 691 90001

Fig. 5 Simple measuring circuit without linearization.



C2 = C3 = 47pF P100
C4 = 3 ... 40pF catalogue
C6 = 22pF P100 number as Fig. 5.

H = HUMIDITY SENSOR

Fig. 6 Measuring circuit with linearization and stabilized supply.

Capacitive humidity sensor

Voltage stabilization is achieved by transistors TR_1, TR_2 and TR_3. TR_1 acts as a series regulator, reference being provided by the base-emitter voltage of TR_2. The collector current of TR_2 drives TR_3 which acts exclusively as an amplifier. The temperature dependence of the reference voltage is compensated by a 68 kΩ NTC thermistor. A 220 kΩ variable resistor is used to adjust the supply voltage to 4,2 V.

The principle of the linearizing circuit is illustrated in Fig. 7. Voltage pulses supplied by the meaning circuit of Fig. 6 charge capacitor C via diode D and resistor R_1. At the same time a discharge current proportional to the voltage across the capacitor flows through resistor R_2 and an additional current flows from the 4,2 V supply line via resistor R_3. The output voltage V'_o is thus a non-linear function of $\bar{V}_o$, and by judicious choice of C, R_1 and R_2, this function can be so profiled that the relationship between H_{rel} and V'_o is made substantially linear.

Figure 8 shows a printed circuit board for a version intended for use with a meter (50μA, 1kΩ), and Fig. 9 shows a version mounted on an identical circuit board producing an output voltage between 0 and 1 V (for use in an automatic humidity control system). Note that the same circuit board can be used for the circuit of Fig. 5.

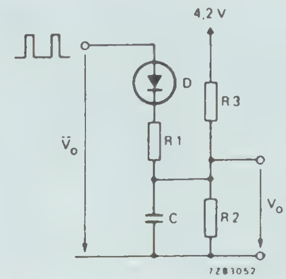


Fig. 7 Principle of the linearizing circuit.

Figure 10 illustrates how the circuit of Fig. 6 can be adapted for connection to an external power supply providing a voltage V_B of at least 7 V. Resistor R_8 should be chosen such that $R_8 \approx (V_B - V_{ST})/2$ mA, where V_{ST} is the voltage required to supply the measuring circuit (6,5 V ± 5% maintained by a temperature compensated reference diode BZV11).

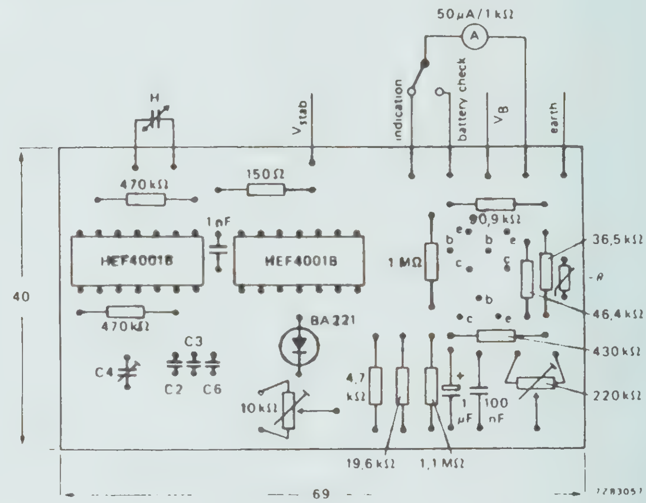


Fig. 8 Printed circuit board equipped with components for connection to a meter.

Capacitive humidity sensor

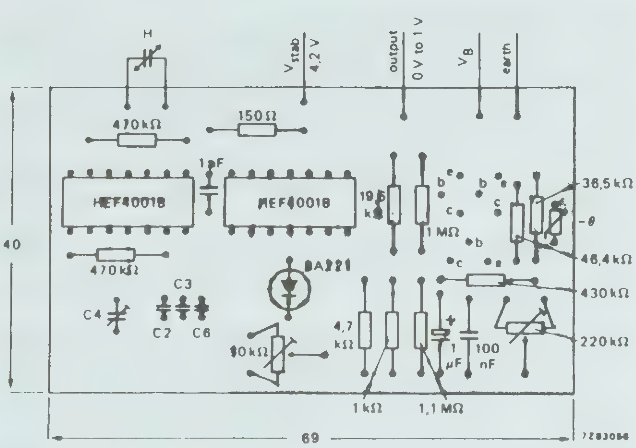
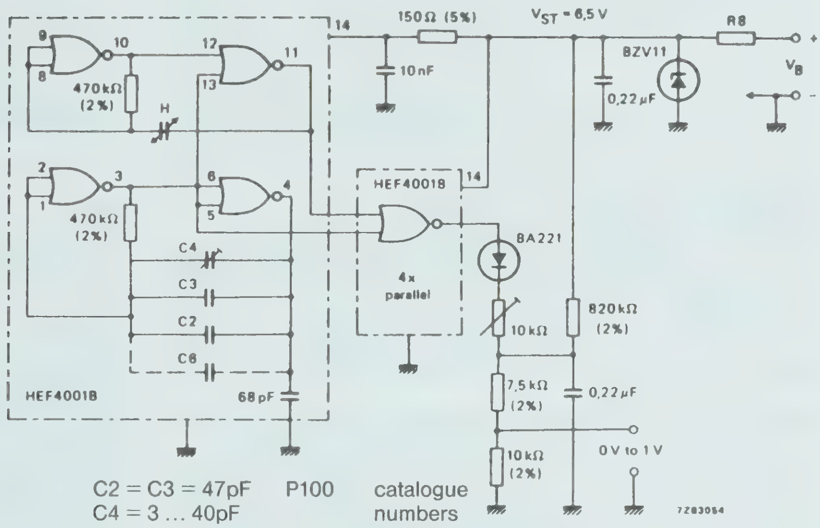


Fig. 9 Printed circuit board equipped with components for supplying the monitoring voltage of a control system.



C2 = C3 = 47pF P100 catalogue
C4 = 3 ... 40pF numbers
C6 = 22pF P100 as Fig. 5.
H = HUMIDITY SENSOR

Fig. 10 Measuring circuit suitable for connection to an external stabilized supply.

Capacitive humidity sensor

ADJUSTMENT PROCEDURE

To obtain optimum performance the following adjustment procedure is recommended.

- By means of the 220 kΩ variable resistor, adjust the supply voltage to 4,2 V. (This step is omitted for the circuits of Figs 5 and 10.)
- Replace the humidity sensor by a 118 pF capacitor and adjust C_4 to produce a minimum output signal.
- Replace the 118 pF capacitor by one of 159 pF and adjust the 22 kΩ potentiometer (in Fig. 5) or the 10 kΩ potentiometer (in Figs 6 and 10) to produce full scale deflection on the meter (if used) or an output of 1 V.
- After removing the 159 pF capacitor, replace the sensor and readjust C_4 until the output (either voltage or meter reading) corresponds to the ambient humidity (measured by independent means with H_{rel} preferably about 50%).

CHARACTERISTICS OF THE HUMIDITY SENSOR

The relationship between H_{rel} and C_s (Fig. 1) can be approximated by:

$$C_s/C_s(12\%) = 0{,}985 + 0{,}34(H_{rel}/100)^{1,4}$$

where $C_s(12\%)$ is the capacitance at $H_{rel} = 12\%$.

Capacitance C_s depends to some extent upon the operating frequency. This is illustrated in Fig. 11 which shows the influence of frequency upon capacitance based upon a reference frequency of 100 kHz. As further illustration we present Table 2 which gives values of C_o (at H_{rel}=0%) for four different frequencies. Also shown are values of ΔC at H_{rel}=12% and 100%.

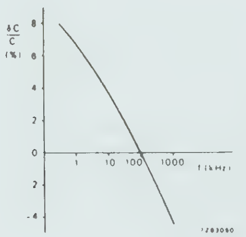


Fig. 11 Influence of frequency upon sensor capacitance C_s based upon a reference frequency of 100 kHz. (Note this curve also represents the influence of frequency on ΔC and C_o.)

TABLE 2 Capacitance of the humidity sensor adjust reference frequencies (nominal values)

frequency f (kHz)	C_0 (pF) (H_{rel} = 0%)	ΔC (12%) (pF)	ΔC (100%) (pF)
1	116,1	3,6	45,5
10	112,7	3,5	44,2
100	109,0	3,3	42,7
1000	104,6	3,3	41,0

The response of the sensor is shown in Fig. 12. Following a rapid change of humidity, a time of about 3 minutes is required for the sensor to again provide a stable reading.

Some important additional data on the humidity sensor are presented in Table 3.

Note that if H_{rel} exceeds 90%, even slight temperature variations can lead to condensation of water on the sensor foil; this in turn will cause measuring errors and a considerable increase in response time. Also, although it is feasible to measure values of H_{rel} below 10%, the sensitivity of the sensor is not specified in this region.

TABLE 3 Characteristics of the humidity sensor

capacitance (T=25°C, H_{rel}=43%, f=100 kHz)	122pF ± 15%
sensitivity (H_{rel}=43%)	(0,4 ± 0,05)pF/%
operating frequency range	1 kHz to 1 MHz
temperature dependence (over operating frequency range)	≈0,1%/K
measuring range	H_{rel} between 10% and 90%
operating temperature range	0°C to 60°C
storage humidity range	H_{rel} between 0% and 100%
storage temperature range	−25°C to 80°C
maximum operating voltage (a.c. or d.c.)	15 V
dielectric loss (tan δ) (at t=25°C, f=100 kHz)	<35 X 10^{-3}
response (90% value)	
within the range of H_{rel}=10% to 43%	< 3 min.
within the range of H_{rel}=43% to 90% (T_{amb}=25°C, in circulating air)	< 5 min.
hysteresis at one cycle (H_{rel}→10%→90%→10%,	≈ 3% (H_{rel})
soldering conditions	max. 240°C max. 2 seconds

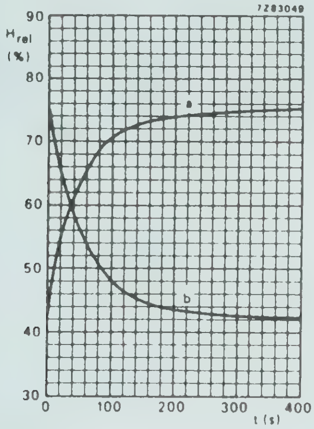


Fig. 12 Response of sensor to rapid changes in humidity (a) from 43 to 75%, (b) from 75 to 43%.

MEASURING ACCURACY

To provide some indication of the accuracy available, we shall consider in this section the major factors contributing toward errors of measurement.

Temperature effects

Since all components used in the circuits are temperature sensitive to some extent, readings from the sensor will be affected by temperature fluctuation.

The sensor itself has a temperature coefficient of 0,1%/K (Table 3) giving a deviation in measurement of 2,5% for a temperature fluctuation of ±25K. However, this is compensated in part by the effect of capacitors C_2, C_3 and C_6 (which are selected for their high positive temperature coefficients).

In the circuit of Fig. 6 a further contribution will come from the diode in the linearizing circuit. The temperature coefficient of the pulsatory voltage at the cathode side is $0{,}5 \times 10^{-3}$/K so that a temperature fluctuation of ±25 K gives a deviation of ±1,25%.

The total temperature effect is given in Fig. 13 (with and without linearization), the absolute value of the deviation ΔH_{rel} being plotted against H_{rel}.

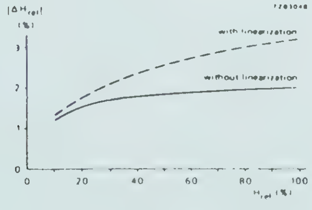


Fig. 13 Total temperature effect as a function of H_{rel} for a temperature fluctuation of ±25 K.

Voltage effects

Fluctuations of the supply voltage produce corresponding changes in output voltage, this effect being independent of the relative pulse width (i.e. t_3/T). In the case of an unstabilized supply a 10% tolerance in battery voltage will thus produce a 10% uncertainty in the output signal. Stabilization of the supply reduces fluctuation to about 1% so that uncertainty in the output signal is reduced accordingly.

Effect of imperfect linearization

Since it is not possible to compensate wholly for non-linearity, errors arising from imperfect linearization are inevitable. These are shown in the graph of Fig. 14. Errors are most pronounced at values of H_{rel}>90%. For H_{rel} between 20% and 90% the error remains below 1%.

The total effect

If the circuit of Fig. 5 (unstabilized supply) is calibrated at $H_{rel} \approx 50\%$, the overall measuring error can be as high as ±10% at the mid-point of the range and ±16% at the 10% and 90% points. Stabilization of the supply voltage (Figs 6 and 10) reduces these errors to ±5% and ±8% respectively. In most cases, however, measuring errors will be far less than these figures.

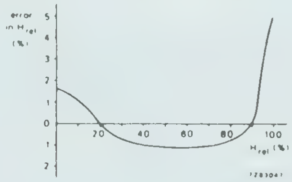


Fig. 14 Errors arising from imperfect linearization.

PRACTICAL HINTS

The formation of dew on the measuring circuit (caused for example by a sudden temperature drop) may lead to surface leakage and hence to false sensor readings. We therefore recommend that all components be given a surface treatment (e.g. plastic spray) prior to their being mounted on the circuit board, and that subsequent to mounting, the soldering side of the circuit board be treated in like manner.

Stray capacitance across the sensor increases considerably if it is connected to the measuring circuit by flexible cable. This leads to a reduction in relative pulse width (t_3/T) and hence to a drop in accuracy. If the use of such cable is unavoidable, the trimmer capacitance should be increased accordingly, and where linearization is employed (i.e. Fig. 6), the resistance in series with the potentiometer should be reduced.

Capacitive humidity sensor

PORTABLE HYGROMETER

VT&S Type: Humidity sensor
Application: Industrial/Domestic
Function: Measurement/Control

Until recently, the only reliable hygrometers were mechanical and were considered too costly for widespread use. With the advent of the electronic humidity sensor, a whole host of applications became possible for electronic sensing circuits, ranging from tumble dryers to industrial air humidifiers. Apart from low cost and reliability, an electronic sensing circuit has several other advantages over mechanical hygrometers.

- It can be incorporated directly into an electrical measuring circuit
- It is easier to operate and maintain
- It can be used to drive a variety of humidity displays and control appliances
- It is easier to calibrate
- It is smaller and therefore ideal for portable applications

You'll now find humidity sensing circuits in:

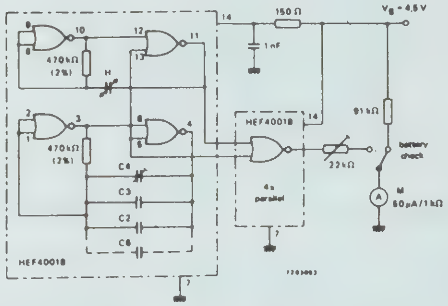
- Air conditioners and humidifiers in factories and at home
- Greenhouse climate controllers
- Tumble dryers
- Automatic extractor fans
- Automatic windscreen wipers
- Microwave-oven safety switch-off (see VT&S sheet 20)
- Home and weather station hygrometers

APPLICATION EXAMPLE

The sensor itself comprises a dielectric foil whose capacitance varies with relative humidity (RH). In a practical circuit the sensor is used in conjunction with two oscillators, one with a fixed frequency and the other with a frequency varying with the sensor's capacitance. The frequency difference is translated into a pulsed output voltage with an average value proportional to the mark/space ratio. This can then be used to drive a meter, graph recorder or LED display (see Fig. 1).

Battery voltage, of course, influences the oscillator frequencies and so a battery check is included in the circuit.

Because the sensor's characteristic is non-linear, the average output voltage used to drive the meter also varies non-linearly with humidity. If a linear scale is required then the circuit shown in Fig. 2 may be added to the output.



C2 = C3 = 47pF P100	2222 632 04479	
C4 = 3 ... 40pF	2222 808 11409	
C6 = 22pF P100	2222 632 04229 (optional)	
H = Humidity sensor	2322 691 90001	

Fig. 1 Simple humidity measuring circuit without linearization

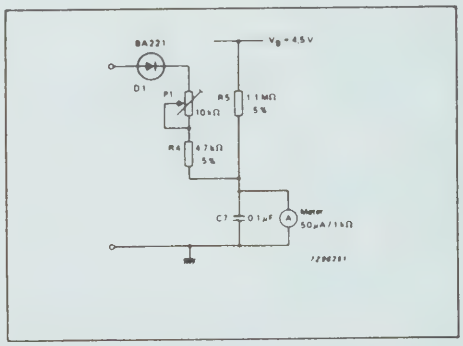


Fig. 2 Linearization circuit for humidity measuring circuit

Capacitive humidity sensor

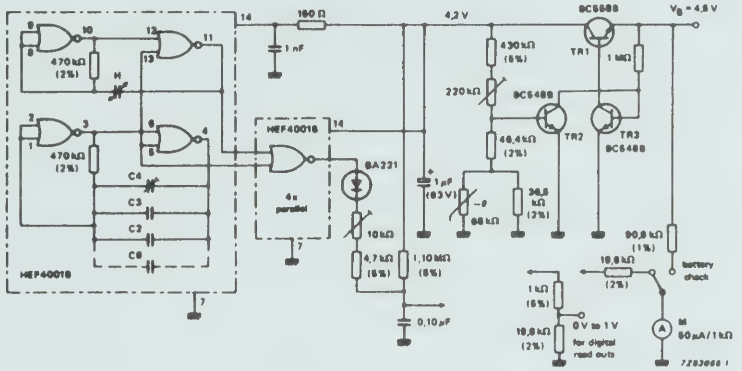


Fig. 3 Measuring circuit with linearization and stabilized supply

Fig. 3 gives a variation of the circuit with a stabilized supply using a 4,5 volt battery. As the total circuit current consumption is only about 100 μA, battery life should be at least one year. Technical Information 063 (ordering code no. 9398 036 30011) describes in detail how the circuit may be adapted for LED or graph recorder displays.

To improve battery lifetime and performance, a higher voltage battery than the necessary 4,5 volts (9 volts, for example) may be used by incorporating a zener stabilizer (see Fig. 4).

Calibration procedure

To calibrate the hygrometer a nominal battery voltage of 4,2 volts is required. The sensor, in Fig. 1 or Fig. 3 is replaced by a 2%, 118 pF capacitor and C4 is adjusted for minimum meter read-out. The 118 pF capacitor is then replaced by a 2%, 159 pF capacitor and the 22 kΩ resistor in Fig. 1, or the 1 kΩ resistor in Fig. 3 is adjusted for a maximum meter readout. With the sensor replaced in the circuit, C4 is again adjusted until a known humidity is correctly displayed. This can be done by placing the sensor in a closed environment with some potassium carbonate (Fig. 5).

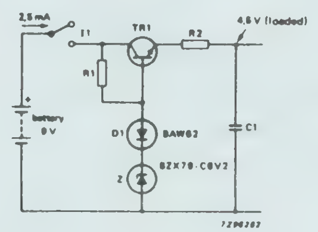
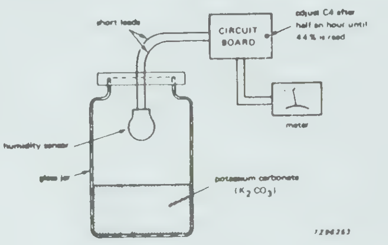


Fig. 4 Zener stabilizer for supply from higher voltage batteries

Capacitive humidity sensor



Temperature (°C)	15	20	25
Relative humidity (%) inside jar	44	44	43

Fig. 5 Calibration procedure for electronic hygrometer

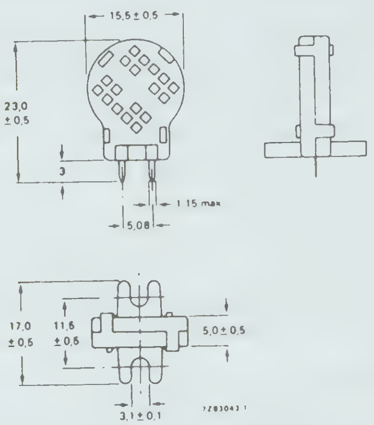


Fig. 6 Outline diagram for the recommended humidity sensor

SUITABLE DEVICE
2322 691 90001 humidity sensor (see Fig. 6)

Humidity range	10 to 90% RH
Capacitance at +25°C, 43% RH	122 pF ± 15%
Sensitivity between 33% and 43% RH	0,4 ± 0,05 pF/% RH
Frequency range	1 kHz to 1 MHz
Maximum a.c. or d.c. voltage	15 V
Storage humidity range	0 to 100% RH
Ambient temperature range	
Operating	0 to +85°C
Storage	−25 to +85°C

Capacitive humidity sensor

HUMIDITY CONTROLLER FOR MICROWAVE OVEN

VT&S Type: Humidity sensor
Application: Consumer
Function: Control

A microwave oven operates by focusing microwave energy onto food which then causes water molecules contained in the food to resonate. This molecular vibration in turn causes heating and then the rapid cooking process begins. The problem with this kind of oven is that food with a high liquid content, soup for instance, could boil over. To prevent this, we suggest a control circuit for the oven containing our humidity sensor which detects an excessive level of steam and then automatically switches off the oven and gives a warning signal.

APPLICATION EXAMPLE

The heart of the circuit (Fig. 1) consists of two identical ICs (HEF4001) although their functions are very different. IC1 is configured as two similar oscillator circuits and IC2 as a simple NOR gate. The frequencies of the oscillators are quite close but one is controlled by a variable capaitor and the other by the humidity sensor's capacitance. Consequently, any rise in the humidity results in the frequency of that oscillator falling, the frequency difference manifesting itself as a pulse train at pin 11 of IC2, with lower mark/space ratio.

The voltage across C4 is then amplified (approximately ten times) by a 532 operational amplifier whose output is then compared with a reference voltage (about 3,1 volts) defined by R8 and R9. If the relative humidity exceeds a predetermined value, output 7 of the operational amplifier goes low, causing a trigger current to flow via R11. Similarly, if the realtive humidity decreases output 7 goes high, the hysteresis being determined by R10. Once the triac is triggered, it can either turn the oven off or switch a fan on.

Continuous triggering uses a lot of power so a sensitive triac (BT136D) with negative triggering is used. The power supply is obtained via a "dropper" circuit from the mains supply, a d.c. existing across C6. The supply for the ICs is obtained via R13 and D3, a 6,2 volt zener diode. Fig. 2 shows a suitable PCB layout for the circuit.

Incidentally, the triac is protected against high voltage spikes by one of our transient protection varistors (2322 593 62512).

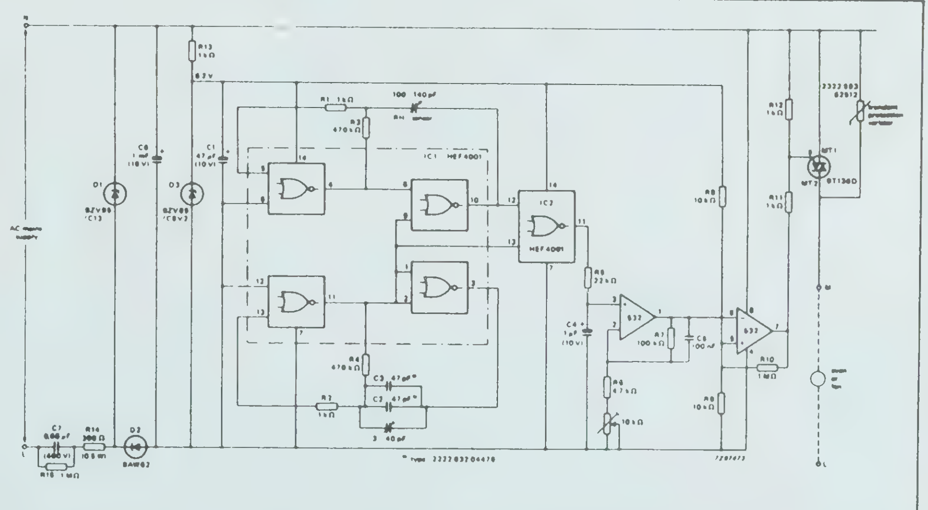


Fig. 1 Humidity control circuit for microwave oven using RH-sensor

Capacitive humidity sensor

SUITABLE DEVICE
2322 691 90001 humidity sensor (see Fig. 3)

Humidity range	10 to 90% RH
Capacitance at +25°C, 43% RH	122 pF ± 15%
Sensitivity between 33% and 43% RH	0,4 ± 0,05 pF/% RH
Frequency range	1 kHz to 1 MHz
Maximum a.c. or d.c. voltage	15 V
Storage humidity range	0 to 100% RH
Ambient temperature range	
Operating	0 to +85°C
Storage	−25 to +85°C

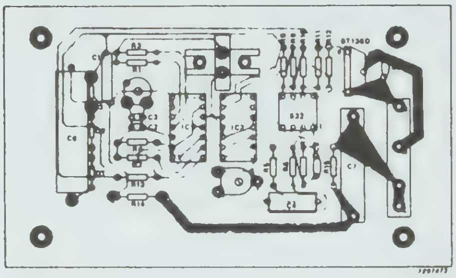


Fig. 2 Printed circuit board for the microwave oven humidity control circuit

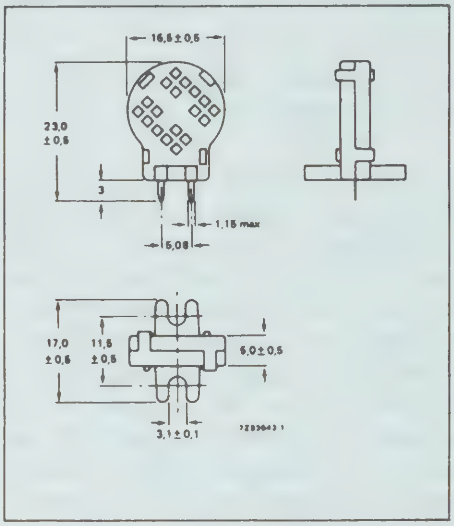


Fig. 3 Outline diagram for the recommended humidity sensor

RESULTS OF TESTING HUMISTORS BY THE NATIONAL AGRICULTURAL INSTITUTE OF THE NETHERLANDS AND BY PHILIPS

Humistors have long been used in such places as greenhouses, offices and meat processing areas, but recent years have seen a significant increase in their use in more aggressive environments such as pig sties and chicken farms. This has prompted a series of investigations into their long-term stability and accuracy, particularly under adverse conditions.

Notable among these investigations have been those carried out on capacitive humistors by the Technical and Physical Research Service, which is part of the National Agricultural Institute of The Netherlands. Interest in the capacitive humistor itself, which consists of a thin hygroscopic polymer foil acting as a dielectric between two electrodes (Ref. 1), was prompted by persistent questions from potential users who felt that 'mirror dew point' meters were too expensive and that wet-and-dry bulb hygrometers (psychrometers) were too laborious to use.

To obtain a reference for stability measurements, all humistors were calibrated in the 30% to 90% RH range at an ambient temperature of 25°C. The humistors were subjected to a 30%–90%–30% humidity cycle in 15% increments, and readings were taken from the humistors at each increment 30 minutes after the climate had reached equilibrium. This cycle was performed twice giving a total of 16 measuring points for each humistor.

ADDITIONAL TESTS PERFORMED BY PHILIPS

Philips has performed a series of additional tests to supplement those done by the Institute, which were not specifically directed towards investigating the humistors' behaviour under adverse conditions.

The tests were performed monthly between July and December. Four typical environments were selected: outdoor environment, cheese store, a pig sty and a greenhouse. Fig. 1 shows the results of these tests.

In particular, the atmosphere in a pig sty (or for that matter a chicken farm) normally contains a rather high proportion of ammonia, and although the results here (Fig. 1(c)) were quite satisfactory, the investigators considered it worthwhile to perform more severe tests.

The most severe conditions that occur in practice would be an ammonia content in the air of 15 mg/m^3 (Ref. 2). To increase the severity of the test therefore, the investigators used air with an ammonia content 100 times this level.

The test conditions were as follows:

- ammonia content of air 1500 mg/m^3
- RH in test chamber 80%
- test duration 10 days
- test temperature +25°C

and the humistors tested were:

- 10 type 2322 691 90001
- 10 type 2322 691 90003

Test results are given below:

Ammonia test results

humistor type	$\frac{\Delta C}{C}$ extremes	$\frac{\Delta C}{C}$ mean	loss factor (tan δ)
90001	+1,7 to +2,8%	+2,3%	0,010 to 0,013
90003	+2,5 to +3,1%	+2,7%	0,010 to 0,012

Capacitive humidity sensor

PANEL 1
EXTRACT FROM INSTITUTE REPORT

At the start of the investigations, all humistors were measured at 14, 25 and 40°C. Within the limits of obtainable accuracy (0,05 to 0,1% RH/K), no deviations from the humistors' specification could be found.

It is emphasized here that all results in this report refer to the humistors alone, and that the temperature coefficients of measuring instruments and humistor combined exceed those of the humistor alone. This means, of course, that a user must take care to verify the quality of his instrument even if a reliable humistor has been used.

CONCLUSIONS AFTER SIX MONTHS' INVESTIGATION WERE:

1. Capacitive thin-film humistors are more stable than resistance type humistors.
2. Most humistors tend to indicate excessive humidity.
3. Humistors outside and in a greenhouse environment show more error than those in pig sties and the cheese storehouse (up to 12% RH compared with 2 to 3% RH). Condensation on the meter, which could be one reason for this, will be investigated further.
4. The hysteresis of capacitive humistors at high humidities must be considered, especially if the humistor is used for control purposes.

 Philips Components • Airport Road, P.O. Box 760 • Mineral Wells, TX 76067 • (817) 325-7871 • FAX: (817) 325-1052

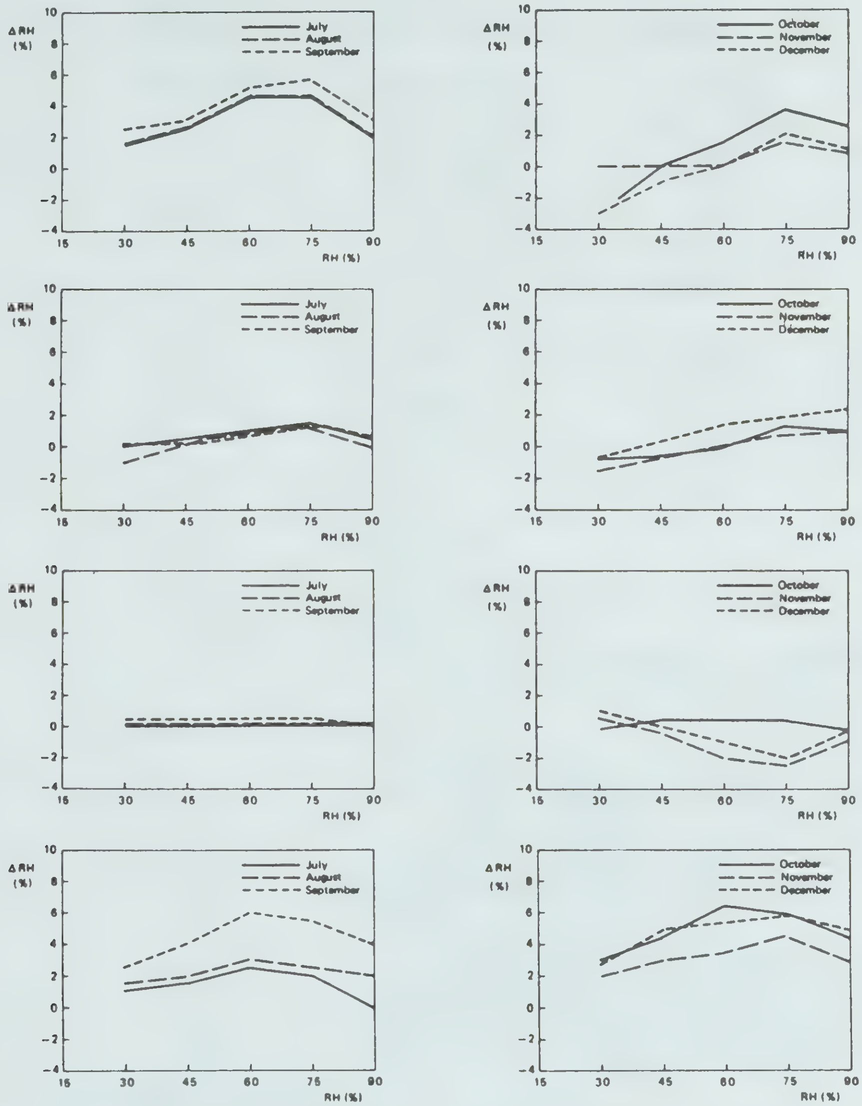


Fig. 1 Graph of humistor stability in various environments.

METAL OXIDE VARISTORS

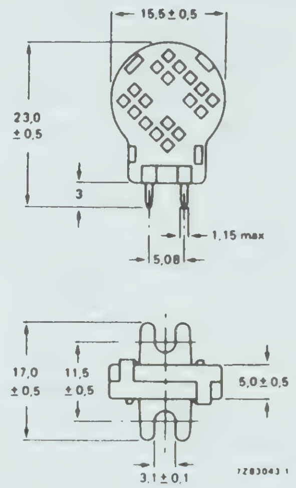


Fig. 2 Dimensions of the capacitive humistor.

On completion of the test, no blemishes or other damage could be found on any of the humistors tested.

These tests apparently caused no problems for the humistors so the investigators decided to test them in even more aggressive environments. They were therefore tested in a saline spray, in an SO_2 atmosphere and in a swimming pool (chlorinated) atmosphere.

From these tests the experiments concluded that the saline spray and chlorinated atmosphere could both cause damage to the humistors, and that, within reason, an SO_2 atmosphere could be tolerated.

REFERENCES

1. Some research on the stability of several capacitive thin-film (polymer) humidity sensors in practice.
   C.J.W. Visscher and K. Schurer.
   Technical and Physical Engineering Research Service, Wageningen, The Netherlands. 1985 Moisture and Humidity Symposium, Washington DC.
2. Geur-en ammoniakemissies bij leghennenstallen. Ing. J.V. Karenbeek, Ir. A.Ph. van Harreveld and Prof. Ir. A.A. Jongebreur. IMAG mei 1985.
3. Philips and MBLE ASS. Quality Control Report nr. 280 by J. Temmerman.

SOLVENCY TESTING OF PHILIPS CAPACITIVE HUMIDITY SENSOR*

SOLVENCY	SOLVENT
5	Ethyl Acetate
5	Acetone
3	HCl, 10%
3	HCl, concentrated
3	Nitric Acid, 10%
3	Nitric Acid, concentrated
2	Sulfuric Acid, 10%
4	Sulfuric Acid, concentrated
4	Alcohols
4	Benzene
5	Methylene Chloride
1	Water
1	Gasoline
4	Lavender Oil
2	Turpentine
2	Ether
2	Formaldehyde
1	Linseed Oil
1	Mineral Oil
2	Premium Gasoline Mixture
5	Orthochlorophenol
2	Perchloroethylene
2	Potassium Hydroxide, 10%
3	Potassium Hydroxide, 50%
2	Carbon Tetrachloride
4	Trichloroethylene
2	Xylene

SOLVENCY CODES:

1 stable
2 stable, waving foil material
3 unstable
4 unstable, waving in foil material
5 soluble

*translated from French (source: manufacturer of polymer dielectric used in Humistor), November, 1987.

COMPETITOR CROSS REFERENCE

COMPETITOR NUMBER	COMPETITOR NAME	PHILIPS COMPONENTS PART NUMBER	PAGE NUMBER
100D-227D	MIDWEST COMPONENTS	2322 660,2322 680	649,679,683
100Q-220Q	MIDWEST COMPONENTS	2322 660,2322 680	649,679,683
100SX	DALE	CT-6H*,8038 EKV	546,541
101	SANGAMO	3188	30
101R	SANGAMO	3188	30
101SR	DALE	CT-6N*	5
101SX	DALE	CT-6X*	545,541
101T	DALE	CT-6R*,8038 EKP	545
101X	SANGAMO	3188	30
102	SEACOR	708D1	408
102	BREL (PMC)	712A1	413
102T	DALE	8038 EKH*	545
106	BREL (PMC)	719A1	418
106	SEACOR	712A1	413
109D	SPRAGUE	40LW	329
109D	SPRAGUE	40EW	313
112	SEACOR	708B1	423
112	FENWAL	2322 626,2322 633	602-606
120	FENWAL	2322 640,2322 642	607,614,615,619
121	FENWAL	2322 626,2322 633	602-606
122	SEACOR	703E1	423
123	SEACOR	719F1	436
130D	SPRAGUE	40LW	329
130D	SPRAGUE	40EW	313
135D	SPRAGUE	40BW	305
135D	SPRAGUE	40AW	298
137D	SPRAGUE	40SW	336
138D	SPRAGUE	40SW	336
139R	SANGAMO	3191	41
140	FENWAL	2322 640,2322 642	607,614,615,619
140D	SPRAGUE	43XW/CLR14	348,227
140D	SPRAGUE	43XW/CL14/CL16	348,212
141D	SPRAGUE	43XW/CLR17	348,228
141D	SPRAGUE	43XW/CL17/CL18	348,214
142	FENWAL	2322 640,2322 642	607,614,615,619
143	FENWAL	2322 640,2322 642	607,614,615,619
145	FENWAL	2322 640,2322 642	607,614,615,619
146XR	AEROVOX (ACUSHNET)	704C1	427
148	MALLORY	703E1	432
150	VRN	RJ-13P*	549
150	FENWAL	2322 640,2322 642	607,614,615,619
150D	SPRAGUE	40SS	373
150D	SPRAGUE	40XS	384
150SX	DALE	8038 EKZ*	542
150TX	DALE	8038 EKR	542
151D	SPRAGUE	40NS	365
152	WESTLAKE	708D1	408
152	FENWAL	2322 640,2322 642	607,614,615,619
152	MALLORY	708D1	408
152D	SPRAGUE	40XS	384
158	MALLORY	719J1	458
158X	WESTLAKE	719J1	458
160	WESTLAKE	712A1,719A1	413,418
160	MALLORY	719A1	418
167/184	MALLORY	719A1	418
167	WESTLAKE	719A1	418
168/185	MALLORY	719A1	418
168	WESTLAKE	719A1	418
170	VRN	CT-6W*,8014 EKW	545
171	VRN	CT-6P*,8014 EKP	545
171	WESTLAKE	719F1	436
171	MALLORY	719F1/F2	436,437
172	MALLORY	703E1	432
172D	SPRAGUE	40TS	380
173D	SPRAGUE	40MS	359
176D	SPRAGUE	40TS	380
179D	SPRAGUE	40YS	388
180	VRN	CT-6W*	545
180W-222W	MIDWEST COMPONENTS	2322 660,2322 680	649,679,683
181	VRN	CT-6P*	545
1817	ROEDERSTEIN	719A1 (370)	418
1818	ROEDERSTEIN	719A1 (371)	418
182	VRN	CT-6X*	545
1822	ROEDERSTEIN	719A1 (344)	418
1823	ROEDERSTEIN	719A1	418
1826	ROEDERSTEIN	719A1 (370)	418
1836	ROEDERSTEIN	719F1 (376)	436
184	WESTLAKE	719A1	418
1840	ROEDERSTEIN	719F2 (378)	437
1841	ROEDERSTEIN	719F2 (378)	437
1845	ROEDERSTEIN	719F2 (378)	437
185	WESTLAKE	719A1	418
186	WESTLAKE	719A1	418
1862	ROEDERSTEIN	719B1 (344)	425
190D	SPRAGUE	41PS	369
195	FENWAL	2322 626,2322 642	602,603,615,619
196D	SPRAGUE	41GS	355
198	FENWAL	2322 626,2322 642	602,603,615,619
199D	SPRAGUE	41GS	355
1C-9C	SPRAGUE	K	142
1D1-3D1	MIDWEST COMPONENTS	2322 640,2322 642	607,614,615,619
1D2-3D2	MIDWEST COMPONENTS	2322 640,2322 642	607,614,615,619
1D3-3D3	MIDWEST COMPONENTS	2322 610,2322 645	600,601,627
1D4-3D4	MIDWEST COMPONENTS	2322 644,2322 645	623,627
1D5-3D5	MIDWEST COMPONENTS	2322 644	623
1D7-3D7	MIDWEST COMPONENTS	2322 644	623
1D9-3D9	MIDWEST COMPONENTS	2322 644	623
1D0-4D0	MIDWEST COMPONENTS	2322 626,2322 633	602-606
202D	SPRAGUE	43JW	320
260-10	VRN	8026 EKP*	540
260-208	VRN	8026 EKW*	
260-207	VRN	8026 EKX*	
3006 Y	BOURNS	CT-20X*	552
3006 P	BOURNS	CT-20P*	552
3262 X	BOURNS	8026 EKX*	540
3262 W	BOURNS	8026 EKW*	540
3262 P	BOURNS	8026 EKP*	540
3266 W	BOURNS	8026 EKW*	540
3266 P	BOURNS	8026 EKP	540
3266 X	BOURNS	8026 EKX*	540
3292 P	BOURNS	CT-9P*,8024 EKP	552
3292 W	BOURNS	CT-9W*,8024 EKW	552
3292 X	BOURNS	CT-9X*,8024 EKX	553
3296 Y	BOURNS	8024 EKY*	538
3296 W	BOURNS	CT-9W*,8024 EKW	552
3296 P	BOURNS	CT-9P*,8024 EKP	552
3296 X	BOURNS	CT-9X*,8024 EKX	553
3299 W	BOURNS	CT-9W*,8024 EKW	552
3299 X	BOURNS	CT-9X*,8024 EKX	553
3299 Y	BOURNS	8024 EKY*	538
3299 P	BOURNS	CT-9P*,8024 EKP	552
32D	SPRAGUE	3188	30
32DR	SPRAGUE	3188	30
32DX	SPRAGUE	3188	30
32M	WESCO	708D1	408
32MM	WESCO	708A1	411
32PC	WESCO	708G1 N/A	
32PMC	WESCO	708B1	423
3314 J	BOURNS	ST-4A	
3323 S	BOURNS	CT-6S*	545
3323 P	BOURNS	CT-6P*	545
356	GUDEMAN	708D1	408
356R	C-D	708D1	408
363	GUDEMAN	708A1	411
4D0-4D5	MIDWEST COMPONENTS	2322 640,2322 645	607 614 627
4M	WESTCAP SFE	719A1	418
500	SANGAMO	3188	30
500R	SANGAMO	3188	30
500X	SANGAMO	3188	30
501	EMCON/KYOCERA	P	158
576D	SPRAGUE	40ZS	392
592C	SPRAGUE	A	132
602D	SPRAGUE	3188	30
602DX	SPRAGUE	3188	30
608	TRW	708D1	408
622D	SPRAGUE	3191	41
636D	SPRAGUE	3188	30
663UW	TRW	708D1	408
715C	CERAMITE,SPRAGUE	T	196
80D	SPRAGUE	3487	60
81B-81G	MIDWEST COMPONENTS	2322 626,2322 633	602,606
81D	SPRAGUE	3488	30
82D	SPRAGUE	3487	60
863UW	TRW	704C1	427
920C-923C	SPRAGUE	P	158
A-21	DALE	5053Y	504
AL-G1	KEYSTONE	2322 626,2322 633	602-606
AS/AR	TRANSISTOR	40BW	305
AT	TRANSISTOR	40AW	298
AWS	NSSI	719F1/F2	436,437
BR3C	TRW	5073Y	504
C	DALE	2322 610,2322 645	600,601,627
C312-C350	KEMET	K	142
C4	CORNING	5043T,5043E	489,513
C410-C440	KEMET	A	132
C5	CORNING	5053T,5053H	494,513
C630C	KEMET	P	158
CA-CB	FENWAL	2322 642	615,619
CAC	AVX,CORNING	A	132
CC50	ANGSTROM	5013V	520
CC55	ANGSTROM	5023V	520
CCA	TRW	5043M,5033V,5043R	511,515,520
CCB	TRW	5053R,5043V	511,515,520
CCF-55	DALE	5043E	489
CCF-50	DALE	5063J	482
CCF-07	DALE	5043E	489
CCL	MIDWEST COMPONENTS	2322 660,2322 644	649,657
CCM	TRW	5033R,5023V	511,515,520
CD	AVX,UNITRODE	P	158
CDH	MIDWEST COMPONENTS	2322 680	679,683
CEA	TRW	5033R,5023V	511,515,520
CEC	TRW	5073Y	504
CEUSM	MARCON	3480	51
CG	MALLORY	3188	30
CG	AVX,UNITRODE	G,A	136,132
CGO	MALLORY	3191	41
CGR	MALLORY	3188	30
CGS	MALLORY	3186	18
CH50	CORNING	5013V	520
CH55	CORNING	5023V	520
CH60	CORNING	5033V	520
CJ50	CORNING	5013V	520
CJ55	CORNING	5023V	520
CJ60	CORNING	5033V	520
CK50	CORNING	5013V	520
CK55	CORNING	5023V	520
CK60	CORNING	5033V	520
CL	KEYSTONE	2322 610,2322 644	600,601,623
CMF-65	DALE	5053R	511,515
CMF-07	DALE	5043T,5043E	489,513
CMF-20	DALE	5053T,5053H	494,513
CMF-50	DALE	5023R	511,515
CMF-60	DALE	5043M,5053H,	494,511,513,515
		5053T,5043R	
CMF-55	DALE	5033R,5043E,5043T	489,511,515,513
CMK	SEACOR	719B1	425
CMR25	CAPAR	5033R	511,515
CMT	MALLORY	40YW	352
CN50	ANGSTROM	5025A	522
CN55	ANGSTROM	5035A	522
CO7	CORNING	5043T,5043E	489,513
CRA60	R-OHM	5043M,5053H,5043R	494,511,515
CRB12	R-OHM	5043T,5053H	494,513
CRB14	R-OHM	5033R,5043E.	489,511,513,515
		5043T,5063J	
CRB20	R-OHM	5023R	511,513
CRB60	R-OHM	5043M,5043R	511,515
CRC	AVX,CORNING	K	142
CS20	CORNING	5053T,5053H	513
CT4	CORNING	5043T	513
CT55	CORNING	5033R	511,515
D-CS	MIDWEST COMPONENTS	2322 610,2322 644	600,601,623
D-ZOV	MAIDA	2322 592,2322 596	573-594
DA-DT	FENWAL	2322 644	623
DCC	MURATA	T	196
DCM	SANGAMO	3186	18
DD	MURATA	U,D,S	184,162
DE	MURATA	D,S	162
DHS	MURATA	T	196
DMP	C-D	712A1	413
E-CS	MIDWEST COMPONENTS	2322 644	623
ERC-65	DALE	5043V	520
ERC-60	DALE	5033V	520
ERC-55	DALE	5023V	520
ERC-50	DALE	5013V	520
ERL-20	DALE	5053U	518
ERL-05	DALE	5033U	518
ERL-07	DALE	5043U	518
ERN 1/4	JARO	5033R	511,515
ERN 1/2	JARO	5043M,5043R	511,515
ERN-SB	PANASONIC	5033R	511,515
ERN55	PANASONIC	5033R	511,515
ERO-50CK	PANASONIC	5043R,5053H,	511,515,513
		5043M,5053T	
ERO-50CH	PANASONIC	5043R,5053H,5043M	494,511,515
ERO-51CKJ	PANASONIC	5053H	494

*Philips Components Part Number "This Cross Reference is not meant to infer exact interchangeability in all instances, but in most cases, pin configuration, performance specifications, and basic dimensions are similar."

NOTE: ALL MATSUSHITA-PANASONIC and SIEMENS part numbers are in series order designated by last set of numbers (Ex. ERZ-C05DK470, S05K30).

COMPETITOR CROSS REFERENCE

COMPETITOR NUMBER	COMPETITOR NAME	PHILIPS COMPONENTS PART NUMBER	PAGE NUMBER
ERO-25CK	PANASONIC	5033R,5043E,5043T	489,511,513,515
ERO-25CKJ	PANASONIC	5043E	
ERO-25CH	PANASONIC	5033R,5043E	489,511,515
ERO-10CK	PANASONIC	5023R	511,515
ERZ-C20DK	PANASONIC	2322 596	573-594
ERZ-C10DK	PANASONIC	2322 594	573-594
ERZ-C14DK	PANASONIC	2322 595	573-594
ERZ-CO5DK	PANASONIC	2322 592	573-594
ERZ-CO7DK	PANASONIC	2322 593	573-594
F	DALE	2322 610,2322 645	600,601,627
F1772	ROEDERSTEIN	719J1	458
FA-FT	FENWAL	2322 640,2322 642	607,614,615,619
FAH	CORNELL-DUBILIE	3186	18
FAHM	CORNELL-DUBILIE	3186	18
FAL	CORNELL-DUBILIE	3186	18
FALM	CORNELL-DUBILIE	3186	18
FAM	CORNELL-DUBILIE	3191	41
GA-GD	FENWAL	2322 626,2322 633	
H-10	KOA	5023Z	507,512
H-8	KOA	5033Z	507,512
HC3	CORNING	5033U	518
HC4	CORNING	5043U	518
HL	NICHICON	3487	60
HN3	CORNING	5033U	518
HN4	CORNING	5043U	518
HN5	CORNING	5053U	518
HN55	ANGSTROM	2025A	522
HN60	ANGSTROM	5035A	522
HN65	ANGSTROM	5045A	522
IR	THOMSON	719A1	418
IRO/MC	THOMSON	719A1	418
IRO607	THOMSON	719A1	418
IRO807	THOMSON	719A1	418
JA-JT	FENWAL	2322 640,2322 642	607,614,615,619
K146Z	AEROVOX (ACUSHNET)	701B1	
KA-KB	FENWAL	2322 640,2322 642	607,614,615,619
KMC	CHEMICON	3480	51
KP1830	ROEDERSTEIN	703E1	432
L04C	CORNING	5033R	511,515
L04D	CORNING	5033R	511,515
L05C	CORNING	5053Y	504
L05D	CORNING	5053Y	504
L161X	AEROVOX (ACUSHNET)	704C1	427
LA-LT	FENWAL	2322 642,2322 644	615,619,623
LB(U)	NICHICON	3476	45
LL	NICHICON	3487	60
LP	MALLORY	3487	60
LP	ELNA	3487	60
LP2	ELNA	3487	60
LP3	ELNA	3487	60
LPS	NICHICON	3487	60
LR	NICHICON	3487	60
LS	PANASONIC	3070	2
LV-1/4	STACKPOLE	5053Y	504
LV-1/2	STACKPOLE	5053Y	504
M	DALE	2322 610,2322 645	600,601,627
M0 1/4	KOA	5043T,5043E	489,513
M192P	MALLORY	708D1	408
M3	STACKPOLE	5033R,5043E	489,511,515
M4	STACKPOLE	5043M,5053H,5043R	494,511,515
M5	STACKPOLE	5053R	511,515
MA-MB	FENWAL	2322 644	623
MAR3	TRW	5013Z	507,512
MAR5	TRW	5023Z	507,512
MAR6	TRW	5033Z	507,512
MAR7	TRW	5063Z	507,512
MB	OHMITE	5033R	511,515
MC	OHMITE	5043M,5043R	511,515
MC	THOMSON	719A1	418
MC65	CORNING	5053R	511,515
MD	THOMSON	712A1	413
MD01-MD02	AVX	P	158
MEA	TRW	5033R	511,515
MF-1	DALE	5073Y	504
MF 1/8	DALE	5043M,5053H,5043R	494,511,515
MF 1/4	DALE	5053R	511,515
MF	PAKTRON	712A1	413
MF 1/10	DALE	5033R,5043E	489,511,515
MF50	KOA, DALE	5023R,5043E	489,511,515
MF55	KOA, RCD	5033R,5043E	489,511,515
MF60	KOA, RCD	5043M,5053H,5043R	494,511,515
MF65	KOA, RCD	5053R	511,515
MF70	RCD	5073Y	504
MFDS	SEACOR	712A1	413
MFF-1	DALE	5073Y	504
MH55	CORNING	5023V	520
MH60	CORNING	5033V	520
MH65	CORNING	5043V	520
MIL07	KOA	5043T,5043E	489,513
MIL20	KOA	5053T,5053H	494,513
MJ65	CORNING	5043V	520
MK55	CORNING	5023V	520
MK60	CORNING	5033V	520
MK65	CORNING	5043V	520
MKC1860	ROEDERSTEIN	708B1	423
MKC1862	ROEDERSTEIN	719B1	425
MKT1817	ROEDERSTEIN	719A1	418
MKT1818	ROEDERSTEIN	719A1	418
MKT1822	ROEDERSTEIN	719A1	418
MKT1826	ROEDERSTEIN	719A1	418
ML104	CADDOCK	5023Z	507,512
ML114	CADDOCK	5023Z	507,512
ML124	CADDOCK	5033Z	507,512
MMB	NISSI	712A1	413
MMC	TRW	5023R,5013V	511,515,520
MME	NISSI	719J1	458
MMH	NISSI	712A1	413
MMK-5	SEACOR	719A1	418
MMKO	SEACOR	719A1	418
MMS	NISSI	719J1	458
MMT	NISSI	712A1	413
MMW	C-D	708A1	411
MO 1/2	KOA	5053T,5053H	494,513
MO-1	KOA	5073Y	504
MPC	NISSI	719F1/F2	436,437
MPE	F-DYNE	708A1	411
MPED2	F-DYNE	712A1	413
MPR	ILLINOIS	719F1/2	436,437
MPT-2R	ITT	719A1	418
MPV	NISSI	719F1/F2	436,437
MR	THOMSON	712A1	413
MSR	ILLINOIS	712A1	413
MTR3	TRW	5013Z	507,512
MTR5	TRW	5023Z	507,512
MTR6	TRW	5033Z	507,512
MTR7	TRW	5063Z	507,512
N146XR	AEROVOX (ACUSHNET)	703E1	432
N159X	AEROVOX (ACUSHNET)	719F1/F2	436,437
N159Z	AEROVOX (ACUSHNET)	719F1/F2	436,437
N161X	AEROVOX (ACUSHNET)	703E1	432
NA-NT	FENWAL	2322 644	623
NA55	CORNING	5033R,5043E	489,511,515
NA60	CORNING	5043M,5053H,5043R	494,511,515
NA60D	CORNING	5043M,5043R	511,515
NA65D	CORNING	5053R	511,515
NC3	CORNING	5023R	511,515
NC55	CORNING	5033R	511,515
NC6	CORNING	5043M,5043R	511,515
NC60	CORNING	5043M,5043R	511,515
NE4	CORNING	5033R,5043E	489,511,515
NE5	CORNING	5043M,5053H,5043R	494,511,515
NE55	CORNING	5033R	511,515
NE6	CORNING	5053R	511,515
NE60	CORNING	5043M,5043R	511,515
NE65	CORNING	5053R	511,515
NH	PANASONIC	3480	51
NLA	NICHICON	3070	2
NM	PAKTRON	719F1	436
NM(HR)	CHEMICON	3487	60
PA	PAKTRON	719F1	436
PC	NICHICON	3480	51
PC	CORNELL-DUBILIE	3476	45
PFDR	EVOX/SEACOR	719F1	436
PFDS	EVOX/SEACOR	719F1	436
PFWA	EVOX/SEACOR	703E1	432
PK	NICHICON	3488	63
PL	THOMSON	719F1	436
PMB	ILLINOIS	719A1	418
PMC-2R	ITT	719B1	425
PME	ROEDERSTEIN	719J1	458
PNKR	EVOX/SEACOR	719J1	458
PNKS	EVOX/SEACOR	719J1	458
PP	PAKTRON	703E1	432
PP11	F-DYNE	703E1	432
PP61	F-DYNE	703E1	432
PR	WESTCAP SFE	708D1	408
PS	THOMSON	719F1	436
PS	NICHICON	3487	60
PS11	F-DYNE	704C1	427
PT	PAKTRON	708D1	408
PTF-65	DALE	5033Z	507,512
PTF-56	DALE	5023Z	507,512
PTF-51	DALE	5013Z	507,512
PTH	KEYSTONE	2322 660,2322 680	649,679,683
PTH451	MURATA-ERIE	2322 662	653,656
PTH487	MURATA-ERIE	2322 672	681
PTH492	MURATA-ERIE	2322 680	679,683
PTH59-PTH63	MURATA-ERIE	2322 660,2322 672	649,681
PX	THOMSON	719J1	458
Q63100	SIEMENS	2322 660,2322 664	649,657
QX5	NICHICON	712A1	413
QXB	NICHICON	719J1	458
QXC	NICHICON	719J1	458
QXE	NICHICON	719J1	458
QXF	NICHICON	719F1/F2	436,437
QXM	NICHICON	712A1	413
QXS	NICHICON	712A1	413
R-25	R-OHM	5043CX	487
R-50	R-OHM	5053CX	487
RD	MURATA	R	190
RE	ELNA	3476	45
RG 1/2	TRW	5053H	494
RG 1/4	TRW	5043E	489
RG07	TRW	5043T,5043E	489,513
RG20	TRW	5053T,5053H	494,513
RGR05	TRW	5033U	518
RGR07	TRW	5043U	518
RGR20	TRW	5053U	518
RH2	ELNA	3476	45
RJ2	ELNA	3480	51
RL-PTS	KEYSTONE	2322 672	681
RL-PTO	KEYSTONE	2322 660,2322 672	649,681
RL-G	KEYSTONE	2322 626,2322 633	649,657
RL-D1	KEYSTONE	2322 640,2322 642	609,614,615,619
RL	ELNA	3476	45
RL-PTF	KEYSTONE	2322 660,2322 664	649,657
RL-PT1	KEYSTONE	2322 672	681
RN 1/2	STACKPOLE	5043M,5053H, 5043T,5043R	494,511,513,515
RN 1/4	STACKPOLE	5033R,5043E	489,511,515
RPA	MURATA	A	132
RPE	MURATA	K	142
RS-1	STACKPOLE	5073Y	504
RW	TRANSISTOR	43JW	320
RX	CHEMICON	3481	56
RX-11	RUBICON	3481	56
S05K	SIEMENS	2322 592	573-594
S07K	SIEMENS	2322 593	573-594
S10K	SIEMENS	2322 594	573-594
S14K	SIEMENS	2322 595	573-594
S20K	SIEMENS	2322 596	573-594
SA	AVX	A	132
SE-1/8	DALE	5035A	522
SE-1/4	DALE	5045A	522
SE-1/10	DALE	5025A	522
SF	SEACOR	704C1	427
SFWA	EVOX/SEACOR	704C1	427
SFX	SEACOR	704C1	427
SG	KETEMA-RODAN	2322 644	623
SG	AMETEK-RODAN	2322 644	
SL	AMETEK-RODAN	2322 660,2322 672	649,681
SL	KETEMA-RODAN	2322 660,2322 672	649,681
SM(VB)	CHEMICON	3476	45
SM55	STACKPOLE	5033R	511,515
SM60	STACKPOLE	5043M,5043R	511,515
SMA 0411	CORNING/DRALORIC	5043M,5053H,5043R	494,511,515
SMA 0207	CORNING/DRALORIC	5033R,5043E	489,511,515
SMA 0204	CORNING/DRALORIC	5023R	511,515
SMA 0617	CORNING/DRALORIC	5053R	511,515
SMA4C	CORNING	5033R	511,515
SMC	CHEMICON	3476	45
SME(VB)	CHEMICON	3476	45
SMG	CHEMICON	3487	60
SMMKO	EVOX/SEACOR	719A1	418
SNR	SANKEN	2322 592,2322 596	573-594
SP	KETEMA-RODAN	2322 660,2322 664	649,657

*Philips Components Part Number "This Cross Reference is not meant to infer exact interchangeability in all instances, but in most cases, pin configuration, performance specifications, and basic dimensions are similar."

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COMPETITOR CROSS REFERENCE

COMPETITOR NUMBER	COMPETITOR NAME	PHILIPS COMPONENTS PART NUMBER	PAGE NUMBER
SP	AMETEK-RODAN	2322 660,2322 664	649,657
SR	AVX	K	142
SX	MALLORY	704C1	427
T	ELNA	3070	2
T	DALE	2322 610,2322 645	600,601,627
T0-55	TRW	5033R,5043E	489,511,515
T0-60	TRW	5043M,5053H,5043R	494,511,515
T0-65	TRW	5053R	511,515
T110	KEMET	40SS	373
T111	KEMET	40NS	365
T120	KEMET	40TS	380
T140	KEMET	40XS	384
T2-60	TRW	5043M,5043R	511,515
T2-55	TRW	5033R	511,515
T2-65	TRW	5053R	511,515
T212	KEMET	40SS	373
T213	KEMET	40NS	365
T222	KEMET	40TS	380
T242	KEMET	40XS	384
T252	KEMET	40YS	388
T262 KEMET	40ZS	392	
T322	KEMET	40MS	359
T323	KEMET	40MS	359
T330	KEMET	41PS	369
T360/362	KEMET	41GS	355
T390/392	KEMET	41GS	355
T9-55	TRW	5033R	511,515
T9-60	TRW	5043M,5043R	511,515
TAC	MALLORY	40MS	359
TAF	AVX	41GS	355
TAP	AVX	41GS	355
TAR	AVX	40MS	359
TAS	MALLORY	40SS	373
TDC	MALLORY	41GS	355
TE	ELNA	3070	2
TER	MALLORY	40SS	373
TH55	TRW	5023V	520
TH60	TRW	5033V	520
TH65	TRW	5043V	520
THF	MALLORY	40ZS	392
TIM	MALLORY	41PS	369
TJ55	TRW	5023V	520
TJ60	TRW	5033V	520
TJ65	TRW	5043V	520
TK	ELNA	3480	51
TK55	TRW	5023V	520
TK60	TRW	5033V	520
TK65	TRW	5043V	520
TL	MALLORY	43JW	320
TLH	MALLORY	40EW	313
TLS	MALLORY	40LW	329
TLW	MALLORY	40SW	336
TLX	MALLORY	40SW	336
TNR	MALLORY	40NS	365
TSNH	PANASONIC	3488	63
TSS	PANASONIC	3487	60
TSU	PANASONIC	3487	60
TSW	PANASONIC	3487	60
TXA	MALLORY	40XS	384
TXE	MALLORY	40XS	384
TXR	MALLORY	40YS	388
TXT	MALLORY	40BW	305
UFM	MARCON	3480	51
UHF	CORNELL-DUBILIE	3188	30
UPC	CORNELL-DUBILIE	3481	56
UW	TRANSISTOR	40EW	313
V-ZC	GENERAL ELECTRIC	2322 592,2322 596	573-594
V-ZA	GENERAL ELECTRIC	2322 592,2322 596	573-594
V-ZT	GENERAL ELECTRIC	2322 592,2322 596	573-594
V-LA	GENERAL ELECTRIC	2322 592,2322 596	573-594
V-LT	GENERAL ELECTRIC	2322 592,2322 596	573-594
V-LC	GENERAL ELECTRIC	2322 592,2322 596	573-594
V119X	AEROVOX (ACUSHNET)	719A1	418
V119Z	AEROVOX (ACUSHNET)	719A1	418
V146X	AEROVOX (ACUSHNET)	708A1	411
V146XR	AEROVOX (ACUSHNET)	708D1	408
V146Z	AEROVOX (ACUSHNET)	708D1	408
V146ZR	AEROVOX (ACUSHNET)	708D1	408
V159X	AEROVOX (ACUSHNET)	712A1	413
V159Z	AEROVOX (ACUSHNET)	712A1	413
V161X	AEROVOX (ACUSHNET)	708D1	408
V161Z	AEROVOX (ACUSHNET)	708D1	408
VZA	THOMPSON	2322 593	573-594
VZB	THOMPSON	2322 594	573-594
VZC	THOMPSON	2322 595	573-594
VZD	THOMPSON	2322 596	573-594
VZG	THOMPSON	2322 592	573-594
WC	PAKTRON	701A1,708A1	411
WC	TRANSISTOR	40LW	329
WD	PAKTRON	701B1,708B1	423
WF70	WESTCAP SFE	708A1	411
WF74	WESTCAP SFE	708B1	423
WF94	WESTCAP SFE	704C1	427
WH	TRANSISTOR	40SW	336
WH11D	SPRAGUE	3070	2
WMC	C-D	708D1	408
WMF	C-D	708D1	408
WPP	C-D	703E1	432
WT	TRANSISTOR	40SW	336
X	DALE	2322 610,2322 645	600,601,627
X440	TRW	719B1	425
X463UW	TRW	708G1 N/A	
X601PE	TRW	712A1	413
X663F	TRW	708A1	411
XTH	MALLORY	43XW/CL14/CL16	348,212
XTH	MALLORY	43XW/CLR14	348,227
XTK	MALLORY	43XW/CLR10	348,225
XTL	MALLORY	43XW/CLR14	348,227
XTM	MALLORY	43XW/CLR10	348,225
XTV	MALLORY	43XW/CLR17	348,228
XTV	MALLORY	43XW/CL17/CL18	348,214
ZA-ZB	FENWAL	2322 644	623
ZP2	IMB	719A1	418

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